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INCLUDING

ZOOLOGY, BOTANY, AND GEOLOGY.

(BEING A CONTINUATION OF THE 'ANNALS' COMBINED WITH LOUDON AND
CHARLESWORTH'S 'MAGAZINE OF NATURAL HISTORY')

CONDUCTED BY

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"Omnes res creatæ sunt divinæ sapientiæ et potentiæ testes, divitiæ felicitatis humanæ:—ex harum usu *bonitas* Creatoris; ex pulchritudine *sapientia* Domini; ex œconomiâ in conservatione, proportione, renovatione, *potentia* majestatis elucet. Earum itaque indagatio ab hominibus sibi relictis semper æstimata; à verè eruditis et sapientibus semper exulta; malè doctis et barbaris semper inimica fuit."—LINNÆUS.

"Quel que soit le principe de la vie animale, il ne faut qu'ouvrir les yeux pour voir qu'elle est le chef-d'œuvre de la Toute-puissance, et le but auquel se rapportent toutes ses opérations."—BRUCKNER, *Théorie du Système Animal*, Leyden, 1767.

. The sylvan powers
 Obey our summons; from their deepest dells
 The Dryads come, and throw their garlands wild
 And odorous branches at our feet; the Nymphs
 That press with nimble step the mountain-thyme
 And purple heath-flower come not empty-handed,
 But scatter round ten thousand forms minute
 Of velvet moss or lichen, torn from rock
 Or rifted oak or cavern deep: the Naiads too
 Quit their loved native stream, from whose smooth face
 They crop the lily, and each sedge and rush
 That drinks the rippling tide: the frozen poles,
 Where peril waits the bold adventurer's tread,
 The burning sands of Borneo and Cayenne,
 All, all to us unlock their secret stores
 And pay their cheerful tribute.

J. TAYLOR, *Norwich*, 1818.



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THE ANNALS

AND

MAGAZINE OF NATURAL HISTORY.

[FIFTH SERIES.]

“..... per litora spargite muscum,
 Naiades, et circum vitreos considite fontes:
 Pollice virgineo teneros hic carpite flores:
 Floribus et pictum, divas, replete canistrum.
 At vos, o Nymphæ Craterides, ite sub undas
 It e, recurvato variata corallia trunco
 Vellite muscosis e rupibus, et mihi concha
 Ferte, Deæ pelagi, et pingui conchyliis succo.”
N. Parthenii Giannettassi Eol. 1.

No. 67. JULY 1883.

I.—*Materials towards the History of Anchinia.*
 By A. KOWALEVSKY and J. BARROIS*.

[Plates I.-III.]

ANCHINIA is one of the most interesting and least known forms of the whole group of Tunicata. Established by Ratlike in 1833 upon notes left by Eschscholtz, this genus has since that time been studied by only a few observers; the only somewhat complete description that we know is that which Carl Vogt has left us of the *Anchinia rubra*, met with in very great numbers at Villafranca, where he found it floating in thousands at the surface of the sea during the months of December and January.

1. The species obtained by us at the same place also possesses a large spot of red pigment in the middle of the body, and other spots of the same colour upon each of the two large papillæ which surmount the incurvent and excurrent apertures. It made its appearance at Villafranca a little later

* Translated by W. S. Dallas, F.L.S., from the ‘Journal de l’Anatomie et de la Physiologie,’ tome xix. January and February 1883. We are indebted to the kindness of M. Jules Barrois and of the conductors of the above journal for permission to have impressions of the three plates illustrating this memoir.

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1

than the time indicated by Vogt; we have only found it occasionally between the months of February and April, and each time in very small numbers.

2. The only form of *Anchinia* that is known (Pl. II. fig. 1) consists of fragments of zooid-bearing stolons of perfect transparency, which are found floating, like the *Salpæ* and *Pyrosomes*, at the surface of the sea.

Our materials for investigation have been rather scanty; we have met with the *Anchinia* only three times, and the first time in bad weather and in a state unfit for examination. Of the two colonies afterwards captured the first alone bore, as described by Vogt, zooids in different stages of gemmation; it is this that we have made use of in our investigations. The second presented zooids all of the same grade, in the adult state. This is a state mentioned by Rathke, but not met with by Carl Vogt. Its existence shows that there is not in this case continuous gemmation at the surface of the stolon, but an unequally rapid development of a series of previously formed germs.

We have not had the opportunity of confirming the observation of Vogt, who, in the great number of specimens examined by him, constantly found one individual surpassing the others in size and attaining as much as a centimetre in length. Nothing of this kind existed in the two specimens examined by us.

3. No observer has as yet given us any information as to the form of generation represented by the zooids attached to the surface of the stolon. Vogt did not detect in them any distinct traces of a stolon or of genital organs; one only of the specimens examined by him showed more or less oviform bodies; but he does not come to any decided conclusion upon this point, and it is even difficult to make out exactly what the *olive-green* bodies indicated by him in this individual really represent.

In our *Anchinia* we have always found perfectly visible genital organs, consisting of a testis and an ovary (Pl. III. fig. 8, *t, o*), situated at the lower part of the intestine, between the heart and the peduncle, and opening by a common canal into the right expansion of the cloacal sac; it is therefore now absolutely certain that the known *Anchinia* is a *sexual form*.

4. The stolon upon which the zooids are fixed is, according to Vogt, a cylindrical contractile canal, with thick walls, composed of longitudinal and transverse fibres, and lined within with a very fine vibratile epithelium.

Unfortunately we have been unable to study the structure

of the stolon in much detail; we have not seen muscular fibres in it; it appeared to us to be a simple hollow tube, formed of a single series of epithelial cells, and enveloped in a very thick tunic, containing here and there stellate cells. The most remarkable thing to be noted in the stolon is a series of large cells (Pl. II. fig. 1, c) superimposed upon the epithelium, and placed upon the median line between the zooids.

The latter are arranged upon a somewhat irregular line and [each] implanted upon a slight projection formed by the epithelium of the stolon; this projection is separated from the peduncle by a double septum composed of epithelial cells; these septa separate at the period when the bud becomes detached from the stolon.

I. Description of Anchinia.

Anchinia (Pl. III. fig. 8), like *Pyrosoma* and *Doliolum*, is a type of Tunicate in which the two apertures, incurrent and excurrent, are directly opposite to each other. The two cavities to which they give access, namely the pharyngeal sac (*Ph*) and the median portion of the cloaca (*cm*), are not, as in the *Ascidia*, attached to one another, but they face each other, and are situated at the two extremities (fig. 8). Between the two there is a space in which the digestive tube is lodged. In consequence of the separation of these two large cavities, the digestive tube, which in the *Ascidia* is situated below those cavities, is included between them in *Anchinia*; it is moreover surrounded to the right and left by the lateral expansions of the cloaca (*cl*), which spread over the pharyngeal sac to form the branchia. It is therefore included in a sort of case, which only communicates above and below with the rest of the general cavity. Fig. 11, which represents a transverse section passing through the two apertures, will serve better than any explanation to render this arrangement intelligible.

Pyrosoma and *Doliolum* also present the same arrangement but with differences which it is important to note. In *Pyrosoma* the median portion of the cloaca is exceedingly small, in fact quite rudimentary, and out of all proportion to the pharyngeal sac, which occupies an enormous space. Its lateral portions, on the contrary, are much developed, and completely cover the whole of the pharyngeal sac, the entire wall of which is converted into branchia.

In *Doliolum* it is quite otherwise. The lateral portions of the cloaca are rudimentary; they do not cover the pharyngeal sac, of which the branchia occupies only the posterior por-

tion; on the other hand the *median portion* of the cloaca attains a considerable development, and has a volume nearly equal to that of the *pharyngeal cavity*.

Anchinia presents this interesting peculiarity:—As regards the arrangement of the great cavities and of the branchia it represents the exact intermediary between the above two great types, *Pyrosoma* and *Doliolum*. In it the median portion of the cloacal cavity is already large, but its dimensions are still very restricted as compared with those of the pharyngeal sac; its lateral parts are likewise better marked off from the median portion than in *Doliolum*, but incomparably less developed than in *Pyrosoma*, and only cover a small portion of the pharyngeal sac. Lastly, the branchia consists, as in *Doliolum*, of a single series of long clefts parallel to the endostyle; but it is wider than in *Doliolum* (fig. 8), and in this respect somewhat approaches that of *Pyrosoma*.

Anchinia is certainly the most complete transition type that we know between the *Salpa* form and the *Ascidia* form, regarded as representing the two extreme types from the standpoint of the arrangement of the two great cavities. It is the most instructive form to study for any one who wishes to form a notion of these important relations.

I pass now to a more detailed description:—

1. *General form*.—The body is very short and thickset, not at all elongated in the form of a little barrel, but extended especially in the direction of its height; its general aspect does not at all resemble that presented by the *Doliola*, but nearly approaches that of the lateral buds destitute of cloaca which are observed upon their tails.

2. *Cloaca*.—Fig. 8 shows the boundaries of the median and lateral portions of the cloaca. The line *lm* indicates the limit of the median portion, and the line *li* that of the left lateral expansion. A little above the buccal aperture (*b*) there is a point (*p*) where the median portion comes almost into contact with the pharyngeal sac, which causes the lateral expansion to appear divided into two distinct parts—an inferior very large one (*cl*) covering the digestive tube, and a superior very small one (*ls*) only surrounding a vacant space belonging to the general cavity, a space which, in the living animal seen in profile, appears as a triangular part of dark colour, already seen and figured by Vogt, who, however, did not attempt to give any explanation of it.

3. *General cavity*.—The two great cavities (pharyngeal and cloacal) so completely occupy the interior of the body that there remains only a mere fissure to represent the general cavity. We observe, however, two great dilatations—one

formed by the cavity of the peduncle (*cp*), the other placed behind the upper part of the pharyngeal sac (*cs*); further, we must reckon as forming part of the general cavity the spaces *ls*, *li*, bounded by the lateral expansions of the cloaca, the former empty, the latter lodging the digestive tube and the genital organs.

4. *Pharyngeal sac*.—The pharyngeal sac, which, of itself, occupies at least two thirds of the internal space, has, like the whole body, a much elevated and abbreviated form; its ventral portion is occupied by the endostyle, which is very short in accordance with the general form. At its posterior portion are placed the branchiæ, in the middle and towards the upper part of which the mouth opens. Lastly, it is traversed through nearly its whole extent by a vibratile line (*lv*), which terminates at the top of the dorsal surface in a spiral, which at this point forms a special organ, *sp*. The nervous ganglion and the vibratile pit are situated a little in front of this spiral organ.

5. *Special organs*. a. *Ciliary band*.—The vibratile band as usual surrounds the incurrent orifice; but in *Anchinia* it is easy to trace it to a great distance on each side. Above it is seen to continue beyond the vibratile (olfactory?) pit and as far as the upper part of the pharyngeal sac, where, becoming recurved, it unites with the band of the opposite side, *sp*, forming at this point the spiral organ already mentioned; in the middle of the spiral formed by the recurved extremity of the vibratile band, the wall of the pharyngeal sac gives off a small cæcum which projects into the general cavity and consists of peculiar cells, smaller than in the rest of the wall and furnished with very strongly refractive nuclei (fig. 8, *sp*).

The same organ exists in *Doliolum*, in which it likewise forms the extremity of the ciliary band, but does not occupy the same situation; it is nearer the incurrent aperture, and *in front of* the nervous ganglion and the olfactory pit.

Vogt has already described it in *Anchinia* under the name of the "lacet recourbé en crochot."

In the opposite direction the vibratile band reaches the endostyle, curves in order to follow it in its whole length, and then rises at its other extremity, to be continued in the median line, between the two branchiæ, to lose itself in the mouth, where, no doubt, it gives origin to the spiral furrow, so well described by Vogt. ("In the anterior part of the digestive tube there is a spiral cord which descends along the œsophagus, commencing from the mouth, and terminating near the stomach by becoming confounded with the general lining of the stomachal cavity.")

The vibratile band is composed of small cells of elongated form, with a large nucleus and small cell-body; these cells are closely juxtaposed in the direction of their length.

The vibratile band appears to have very intimate relations with the endostyle; from the two extremities of that organ we see issue a band having the same structure as the vibratile band, with which it unites at its two points of curvature. Unfortunately we have not succeeded in making out to what portion of the endostyle these two bands belong by penetrating into the interior of the organ.

b. *Nervous ganglion*.—This is situated rather far from the incurrent aperture, but not far from the upper extremity occupied by the spiral organ. It consists of an epithelial portion always united by a slender cord to the upper part of the ciliary pit, and of a mass of nerve-cells which surmounts this. The funiculus which unites the ganglion with the olfactory pit is always very short, never attaining a length comparable to that which occurs in *Doliolum*. The nervous ganglion always remains very near the pit.

c. *Nerves*.—Viewed from the side (fig. 8, left side), the nervous ganglion is seen to give origin to five nerves.

The first pair (1) runs directly forward, passes at but a short distance from the *vibratile pit*, traverses the ciliary band, and terminates about the median line near the upper margin of the incurrent aperture.

The second pair (2), which is longer, follows nearly the same course, but runs lower down, and terminates at the level of the inferior margin of the same aperture.

The third (3) forms a strong and very apparent nervous filament. It runs directly backwards and downwards, and divides not far from its origin, and a little before attaining the branchiæ, into two distinct branches. The first of these branches passes above the branchia towards the tenth fissure, and terminates at the upper part of the excurrent orifice. The second, which is longer, likewise passes over the branchia, about the twelfth or thirteenth fissure, and terminates behind the intestine towards the posterior part of the point of attachment of the peduncle.

The fourth (4) is only a very short filament directed towards the summit of the branchia, and also divided into two very slender branches.

The fifth (5), a little way from its origin, unites with a nerve originating from the opposite side; then the common trunk formed by their union runs backward and to the left of the spiral organ, to reach the great dilatation (*cs*) of the general cavity; it traverses this lacuna in a curve, and reaches

the space included between the two small superior cæca of the cloaca. Lastly, after having traversed this space it terminates at the upper part of the œsophagus, beyond which we have not been able to trace it.

d. *Muscles*.—The muscles are not, like those of *Doliolum*, arranged in bands like the hoops of a barrel. We have only two circular muscles placed round each of the two apertures. To these two muscles at each end we have to add a very characteristic S-shaped muscle which occurs nearly in the middle of the body. This brings the number of muscles of the cutaneous envelope to five. All these muscles are composed of long fibre-cells.

e. *Apertures*.—The incurrent and excurrent apertures are, as usual, furnished with papillæ. Those of the incurrent aperture are tolerably large and generally to the number of from eleven to thirteen, arranged as follows:—on the ventral side two pairs of large papillæ; on the dorsal side two analogous pairs; and lastly, at the sides, between the preceding, sometimes one, sometimes two pairs of considerably smaller papillæ; there is also on the dorsal side, on the median line above the aperture, a large unpaired papilla, furnished with red pigment. At the excurrent aperture the papillæ consist of small teeth regularly spaced to the number of seven on each side; further, on the dorsal side we see rise a long filament with red pigment, and into which the sphincter muscle of this aperture penetrates for two thirds of its length.

This long filament occupies the same place as the dorsal stolon of *Doliolum*, and is not without resemblance in aspect to that stolon, at least in the young state before gemmation. Transverse sections show that it is filled with large very granular cells (fig. 9, *cell*). The skin has not the same structure as on the rest of the body; the layer which constitutes the wall is composed of a fibrous envelope (*fb*), having large cells (*ec*), somewhat analogous to the disseminated cells which are met with in the midst of the tunic. In the interior, in the midst of the large granular cells, we sometimes also find some of these cells *ec*. At *m*, and on the side where the tunic is thinnest (the side turned towards the aperture), we see the section of the two muscles given off by the sphincter of the excurrent aperture.

f. *Digestive tube*.—The digestive tube opens, on the one hand, at the upper part of the pharyngeal sac, and, on the other, in the median part of the cloaca. It is formed by a recurved tube, composed of an œsophagus, a stomach, and an intestine. The stomach, which is short and inflated, bears at its lower part a ramified gland, well known in the

Ascidia. Finally the whole of the digestive tube is surrounded by a network of cells (*r*), which may be regarded as the kidney.

g. *Generative organs*.—The genital glands are situated in the space included between the pharyngeal sac and the cloaca, and in the lower part of this space; they are placed to the right of the intestine, between it and the cloacal expansion of the right side; and both open by a common aperture (*oc*) at the lower part of this cloacal expansion. The mature testis (*t*) consists of a narrow deferent duct and of a voluminous ramified gland, partly concealed by the branchia, and which clothes the whole anterior portion of the intestine. The ovary consists of a common wall (*o*) which contains ova (*ov*) at different stages. The oldest ova are situated at the extremity of the sac on the side opposite to the aperture; then follow two or three ova less and less developed, and finally a small mass of indifferent cells which are placed quite close to the aperture.

h. *Endostyle*.—The very short endostyle presents in transverse sections the structure shown in fig. 10. It is composed of two symmetrical halves, separated by a very deep groove in the buds. Below this groove there is on each side a narrow cell furnished with a very long cilium, which projects out of the cavity of the endostyle. Then comes a zone of radiating cells, at the inner angle of which is seen a small, rounded, and very strongly coloured cell. The radiating zone is succeeded by a second zone, to which carmine attaches itself preferentially; it consists of cells with large nuclei, with no great amount of protoplasm, which alternate more or less, and are not, like the preceding, arranged in a single row. Lastly, this second zone is surmounted by a large clear cell, which bears at its inner angle a rounded and very strongly coloured cell. This last bounds the aperture of the endostyle. The whole inner surface of this organ seemed to be furnished with fine cilia.

It is at the inner angle of the coloured cell that is inserted the wall of the pharyngeal sac, which commences with a cell larger than the others, and the existence of which appears to be constant (fig. 10). From this point the wall acquires its definitive structure, formed of long flattened cells. Nevertheless we do not see it immediately take a direction to the right and left to form the lateral parts of the pharyngeal sac. In

* fact it begins by rising upwards, and then bends round, forming a small loop occupied by a few thicker small cells; these last are nothing but the section of the vibratile line of each side; and we see therefore that this line, in the part of it which is horizontal and parallel to the endostyle, is not

situated directly upon the wall of the pharyngeal sac, but upon a special fold.

After forming this fold, the layer of flat cells (*end*) bends regularly to the right and left to form the walls of the pharyngeal sac.

i. *Heart and peduncle*.—The heart, as usual, is situated at the posterior extremity of the endostyle; it is placed not far from the genital organs, and, like the latter, occupies a place not distant from the peduncle.

The stout peduncle which unites the *Anchinia* to the stolon persists during the whole life; it is stopped at its lower part by an epithelium thicker than on the rest of the body; and it occupies nearly the same position as the stolon of the colonies of *Pyrosoma*.

II. Gemmation.

1. The youngest stage observed by us (figs. 2, 3) was already completely separated from the stolon (fig. 1. no. 3), but still possessed a rounded form without any trace of the division into body and peduncle.

When detached from the stolon and examined under a greater magnifying-power, this bud presented most of the organs already formed—in the middle the pharyngeal sac with the endostyle, the oesophagus, and the stomach. Around the latter there is a mass of large cells, among which may be observed some still more voluminous; between this last and the endostyle the pericardium; and lastly, above the pharyngeal sac and opposite to the endostyle, the ganglionic mass, hollowed out by a cavity in its posterior portion.

It is to be remarked that, in this first stage, the endostyle occupies nearly the anterior extremity, the pericardium and the ganglionic mass occupy nearly the middle of the two surfaces of the bud; and these relations, which completely alter afterwards, are none the less remarkable and worthy of notice.

Further, we must note the enormous development and the peculiar almost spherical form of the endostyle.

In the early development of the endostyle and its situation at the upper part of the bud there is nothing that need greatly astonish us; we here find the same thing as in the *Salpæ*.

Lastly, we have found nothing at this period that can be referred to a cloacal sac; moreover, as yet there exists no aperture by which the bud is placed in communication with the outer world.

2. In the following stage (fig. 4) the bud has lost its rounded form to acquire a clavate form, in which we already begin to be able to distinguish a division into body and

peduncle (fig. 1, nos. 4 and 5). In it the internal organs present relations absolutely different from those which we have seen in the preceding stage. The cloacal sac is now formed; it occupies the space situated between the ganglionic mass and the peduncle, and presses upwards the ganglionic mass. In consequence the latter, which was previously placed towards the middle of the dorsal surface of the bud, is approximated to its upper part (figs. 1, 3, 4), while the endostyle quits that position to be more or less completely pushed over towards the ventral surface.

The pharyngeal sac of the preceding stage, as well as the cloaca, is in communication with the exterior world; the two apertures (incurrent and excurrent) exist, and are each of them surrounded by two muscles; the digestive tube is completed by the addition of an intestine which opens into the cloaca; and, as before, there exists a rounded stomach, which constitutes its most voluminous part.

The endostyle has already more restricted dimensions relatively to those of the surrounding organs; in its middle part it presents a deep groove which divides it into two parts.

The pharyngeal sac begins to present a thickening (*lv*), which forms the first indication of the vibratile band.

The ganglionic masses possess a much more definite structure than in the preceding stage. There may be distinguished in it two very distinct parts:—(1) a hollow portion united to the pharyngeal sac by a hollow peduncle, and which appears to be only a cæcal expansion of the wall of that sac; and (2) a solid portion surmounting the former and composed of ganglionic cells, the latter representing the cerebrum properly so called.

The mass of cells which surrounded the intestine appears better circumscribed than in the previous stage; it has become concentrated into an elongated mass placed to the right of the intestine, and which, in its posterior part, presents some more voluminous cells. This mass represents the common rudiment of the two genital glands, testis and ovary: its posterior part, containing the large cells, will form the ovary; and the large cells themselves are nothing but the ovules.

The whole wall of the body is composed of an epithelium of considerable thickness, except at the level of the genital mass, where it consists of flattened cells.

3. In the succeeding stage (fig. 5, not represented in the general figure) the nervous ganglion has definitively reached the summit of the bud; so that the change of form already

Taking as the longitudinal axis a line drawn from the ganglionic mass to the pericardium, we can already recognize a general arrangement of the body analogous to that which exists in the adult; but we see that the part which lodges the genital mass is much more developed than in the adult, which causes the peduncle to be much nearer the upper part.

Except for a slightly more advanced development, the internal organs are in the same state as in the preceding stage. The stomach has become narrower, and the intestine more elongated, which causes a notable alteration in the whole aspect of the digestive tube; further, the lateral parts of the cloacal sac have become elongated, so that already they surround the digestive tube and have come to communicate with the pharyngeal sac.

The genital mass now presents a very perceptible division into testis and ovary (fig. 5); it appears disaggregated at its anterior part, thus giving origin to isolated cells, probably the same as those which afterwards occur around the intestine and which apparently represent the kidney.

At the same epoch we begin to see distinctly the ciliary band (*lv*) and the S-shaped muscle, which occupies nearly the middle of the body; further, the heart has been formed in the interior of the pericardium.

4 (fig. 6, and fig. 1. 6-7). Later on the assimilation to the adult becomes easier and easier; nevertheless the posterior part corresponding to the genital mass still for a long time presents a very considerable development, producing a form quite different from that of the adult; lastly, the nervous ganglion has already ceased to occupy the summit of the body, and begins to pass towards the anterior side.

The most remarkable change of this epoch consists in the formation of the branchial fissures between the pharyngeal sac and the lateral portions of the cloaca which cover its posterior surface. The branchial fissures are formed in a single line, and appear nearly all at the same epoch; nevertheless those of the middle are more developed than those of the extremities. They make their appearance at first in the form of small slightly elongated thickenings; and it is only subsequently and very gradually that they acquire the breadth which they afterwards present.

The modifications previously described in the digestive tube have become more and more strongly marked at the epoch under consideration: the stomach has become considerably contracted, and the entire digestive tube has acquired the form of a bent cord which occupies a perfectly vertical position; moreover the intestine has become greatly

elongated, and represents by itself the whole of the posterior branch besides a portion of the anterior; at this stage it also presents an inflated portion, which afterwards disappears and does not exist in the adult.

The ovary, the testis, and the disseminated cells (of the kidney?) are more distinct from each other, and begin to be clearly recognizable.

Finally the margins of the incurrent and excurrent apertures begin to thicken in order to form papillæ, while over the rest of the body, especially at the level of the endostyle and of the nervous ganglion, the epidermis becomes considerably reduced in thickness.

5. In the state represented by fig. 7 the bud has lost all its embryonic character and acquired an aspect which absolutely resembles that of the adult; the summit of the body is no longer occupied by the nervous ganglion, but by the *spiral organ* (as is shown in fig. 1. 7-8, and fig. 7); the general aspect has completely changed; the cells which form the external laminae as well as the pharyngeal and cloacal sacs have acquired the flat form which they present in the adult; and the general transparency has become very great; the pharyngeal sac has considerably increased; the endostyle has lost its inflated form to acquire an aspect approaching that of its definitive form; and, lastly, the whole region of the genital mass has been reduced in such a manner that the peduncle, instead of retaining its original direction, is now directed downward, occupying a position absolutely different from its previous one and much nearer to the heart. It is this last alteration especially that modifies the general aspect presented by the bud and gives it an absolutely different form.

The internal organs have also undergone modifications of some importance. Of the two muscles which bounded each of the apertures (incurrent and excurrent) the posterior one is now further from the aperture, and the anterior one alone borders it closely. Further, the thickened margin of the posterior aperture begins to be recurved at its upper part to form a sort of hook, into which the muscle penetrates, and which is the commencement of the long filament that occupies this position in the adult.

The branchia has become elongated and recurved, as shown in the figure; but the branchial fissures are only slightly lengthened.

The intestine has continued to be developed in the direction already indicated in the preceding stage; but the kind of cæcum formed previously (cæ) at its lower part has disap-

peared, and nothing remains of it except a dilatation of the corresponding region, a dilatation, however, which disappears in the adult to produce a slender and perfectly uniform tube. Lastly, at the base of the stomach we notice the slender tube which represents the ramified gland of the *Ascidia*.

The vibratile band is now very distinctly formed; and it can easily be traced throughout its whole extent up to the spiral organ, which is already present.

The genital masses have decidedly given place to a definitively separated testis and ovary, the former composed of rounded cells and the latter of a follicle containing several ova; both of them open by a common aperture into the right lateral expansion of the cloaca.

Lastly, the disseminated cells have lost all connexion with the genital organs; they are now arranged in groups of four or five around the digestive tube.

6. In the adult the branchial clefts have increased very perceptibly; the peduncle has attained a vertical position and come to be placed in the immediate vicinity of the heart; it is much less apparent than in the preceding stage; and the whole animal has acquired the definitive form of the figure 8. The cells of the kidney are no longer collected into groups as previously, but form a *network* around the digestive tube. The testis presents a deferent canal; and its glandular portion has become elongated and ramified around the stomach, which it partly conceals. Finally, the tunic has become much thickened; and spots of red pigment have made their appearance in the middle of the body and above the apertures.

III. *Affinities.*

We have already put forward some considerations upon the central position, between the two great extreme groups of the *Salpæ* and *Ascidia*, and especially between *Doliolum* and *Pyrosoma*, that is occupied by *Anchinia* from the point of view of the arrangement of the great cavities. But these general relations give us but little information as to the precise affinities of this interesting type and the exact place - which ought to be assigned to it from the complete knowledge of its organization.

If we endeavour to compare the preceding description with what we know of the other Tunicata, we find that, as regards the structure of the adult as well as the position of the buds upon the stolon, *Anchinia* presents a great resemblance to *Doliolum*.

As regards the organization of the adult form, we see that

the disposition of all the internal organs especially approaches that of *Doliolum*; the cloaca, the branchia, the endostyle, the intestine, and the genital organs have a form and arrangement almost the same as in the latter. Leaving out of consideration the regular form of a little cask, with muscular bands representing its hoops, which *Doliolum* possesses, the same description might apply to both.

The conformity is still greater if, instead of comparing *Anchinia* with the adult form of *Doliolum*, we compare it with the buds. These are attached to the stolon which bears them, by a peduncle, of which the point of attachment is at the level of the endostyle, and which throws the cloacal aperture towards the dorsal or neural side. The presence of this peduncle and the dorsal position of the aperture of the cloaca constitute of themselves a resemblance of great importance between *Anchinia* and *Doliolum*; but its significance becomes much greater when we consider that the *Anchinia* absolutely resemble the buds of *Doliolum* in the conditions of their existence. We may suppose that the *Anchinia* are *Doliola* which have remained stationary, and which retain throughout life up to sexual maturity the embryonic form of the buds of *Doliolum*. In *Doliolum* the buds, in order to attain to sexual maturity, separate from the stolon and commence an errant life, during which their musculature and their general form become adapted to these new conditions of existence. In *Anchinia* the buds remain attached to the stolon, attain sexual maturity in this state, and retain throughout life the embryonic form of the buds of *Doliolum*.

The more detailed comparison of the buds of *Doliolum* with those of *Anchinia* also reveals great resemblances; the peduncle which attaches the *Doliolum* to the stolon upon which it is implanted has its point of attachment to the animal situated between the endostyle and the cloacal aperture; the same thing occurs in *Anchinia*, as in most of the Tunicata which are reproduced by gemmation; but between these last and *Doliolum* and *Anchinia* there exists a very grave and indeed capital difference: in the Tunicata generally the union which takes place at the level of the peduncle, between the bud and the parent or the stolon which has given origin to it, is quite intimate; the ectoderm of the buds is only the prolongation of the ectoderm of the parent or of the stolon, and its endoderm passes directly into the endoderm of the stolon (as in the Salpæ) or of the parent (as in the Ascidia, *Pyrosoma* &c.). On the contrary, in *Doliolum* and *Anchinia* the peduncle of the bud is simply adherent (attached without intimate union of the tissues) to a small corresponding elevation of the stolon.

The peduncle of the buds of *Anchinia* (fig. 7, *cp*) represents a simple elevation of the ectoderm of the bud; it is quite circumscribed; its tissues, which consist of a cylindrical epithelium, all belong to the embryo and have no genetic relation to the stolon; at the point of adhesion to the stolon its cells are merely superposed upon the cells of the corresponding part of the stolon without there being any amalgamation or intimate union; further, the internal cavity of the peduncle is completely closed and does not communicate with that of the stolon. The buds and the stolon appear to be two distinct structures, which are only approximate and in apposition to one another, without any direct passage between their tissues, and without any amalgamation of the histological elements. We might compare these relations to those which exist, in the *Mammalia*, between the uterus and the embryo contained in it. The ovum and the embryo to which it gives origin are formations independent of the uterus. The ovum is formed in the ovary, passes into the uterus, becomes attached thereto for a definite purpose; and there are no genetic relations between the two. The same thing appears to take place in *Anchinia*: the buds and the stolon have no genetic relations; the buds are placed upon the stolon for the purpose of their ulterior development; but nothing authorizes us to think that they are produced by the stolon; all our endeavours to detect any relation between the buds and the stolon have been in vain; the youngest buds, like the older ones, were always perfectly independent of the wall of the stolon, whereas, on the contrary, nothing is easier to prove than the direct relations which exist between the organs of the buds of *Pyrosoma*, the *Salpæ*, and the *Ascidia*, and the corresponding organs of the parent. We thus come to the conclusion that the buds of the *Anchinia*, in their genetic relations, are independent of the stolon.

It would be very difficult to explain the apposition of the buds of *Anchinia* if an ingenious discovery of our colleague, M. Oulianine, had not given us the key. Formerly M. Oulianine discovered that the buds of *Doliolum* are not formed upon the stolon of *Doliolum*, but that they originate, as in all the other *Tunicata*, at the end of the endostyle, upon the organ which has been called the rosette-shaped organ (*rosettenförmige Organ* of the Germans). This organ is the true proliferous stolon of *Doliolum*; it produces buds in accordance with the ordinary process in the *Tunicata*; these buds separate from the rosette-shaped organ, pass to the posterior stolon of the *Doliolum*, become attached to it, and begin to be developed. Thus they are genetically quite independent of the stolon

which bears them. It is to be supposed that an analogous process takes place with the buds of *Anchinia*, and that, after being detached from their place of origin, they become implanted upon the stolon, with which we have been unable to find that they have any genetic relations. This constitutes a further important fact which approximates *Anchinia* to *Doliolum* and separates it from the other Tunicata.

We may now pass to another point, namely the investigation of the arrangement of the buds upon the stolon. As we have already said, we have met with *Anchinia* only on three different occasions.

The first time there were brought to us only a few mutilated individuals torn from the stolon: all these individuals were well developed; all had perfectly formed ovaries and ramified testes filled with spermatozooids, and with the central part of an opaque white tint, indicating a state of complete maturity.

The second specimen consisted of a chain about 10 centim. long, and bearing buds at different stages of development. We omitted to count the number of buds of different ages; but there were rather more young buds than adults (designating under the latter name the individuals possessing a complete intestine filled with food); we found no regularity in the arrangement of the buds, which, on the contrary, seemed to us to be quite irregular: all along the stolon the adult *Anchinia* were intermixed with young buds of different degrees of development; so that at each point one found mixed together adult individuals capable of feeding themselves, and young buds, the nutrition and growth of which could only be effected at the expense of the nutritive substance accumulated in their cells (as in embryonic cells in general) or by endosmosis, at the cost of the nutritive substance contained in the cavity of the stolon.

The presence of adult individuals among the young buds reminds one, to a certain extent, of the arrangement of the buds of *Doliolum*. It is well known that there exist on the dorsal stolon of *Doliolum* two kinds of buds—*median buds*, which will give origin to sexual animals, and *lateral buds* of very peculiar organization; they possess neither genital organs nor proliferous stolon, but have a well-developed intestine and branchiae which function very early. Gegenbaur, Fol, and Grobben have expressed the opinion that these lateral buds are more properly respiratory and nutritive buds; and it is a fact that their organization is wonderfully well adapted to this purpose. Grobben has discussed the

question in detail, and demonstrated that the lateral buds must really be regarded as individuals charged with the above functions.

Thus upon the stolon of *Doliolum* there exist young median buds of which the organs of nutrition and respiration are not yet developed, and lateral buds which possess large branchiæ as well as a completely developed intestinal canal, and a part of which, thanks to their early development, nourish the less developed buds.

In *Anchinia* there is only one kind of bud; there are none which are specially appropriated to the functions of nutrition and respiration. But among those whose development is more advanced we find a certain number whose organs of digestion and respiration are in complete activity. They can the better perform their functions because they are scattered among younger buds throughout the length of the stolon; and they present a most evident analogy of function with the lateral buds of *Doliolum*.

We have studied the position of the buds upon the stolon, their relations with it, and, lastly, their reciprocal arrangement on its surface; and we have found that in these three points their relations are the same as those which exist between the buds of *Doliolum* and the dorsal stolon.

It is well known that in *Doliolum* this stolon is produced by an asexual form, which loses all its organs of nutrition, and becomes reduced to a mere motory organ—an individual whose business is to carry the chain, and whose brief existence only lasts for the time necessary for the maturation of the buds.

In *Anchinia* we do not know the corresponding asexual form. But the close resemblances that we have just indicated between all the other points of organization and reproduction in *Doliolum* and *Anchinia* appear to us to be so striking as to permit us to conclude that the generation which produces the stolon of *Anchinia* resembles *Doliolum*, or even that it is simply a *Doliolum*.

It remains for us, in conclusion, to discuss a final question—that of the ultimate fate of the buds of *Anchinia*.

It is a fact worthy of remark, that of the three specimens of *Anchinia* which have come into our hands, two furnished us only with individuals which had all arrived at complete maturity, and were furnished with genital organs and a digestive tube perfectly developed. There were no longer any traces of fresh buds, or of parts capable of producing them; there existed in them only a single mode of reproduction—sexual generation.

The first time all the individuals collected had the testes much ramified, opaque, swelled with semen; they had been captured in the muslin net in stormy weather, and were unfortunately few in number, and all more or less mutilated. Our second capture consisted of a well-preserved colony, all the individuals of which were mature and presented voluminous ova; but in them the testes were less developed than in the specimens first brought in.

These observations lead to the supposition that the individuals of a colony of *Anchinia* function sometimes all as males and sometimes all as females; it would then be here as in the *Salpæ*, among which the chains function successively at first as male and then as female chains, owing to the fact that in the same chain the male and female organs do not reach maturity simultaneously.

Sexual reproduction is therefore, above all, the purpose of the buds of *Anchinia*. What is the form to which the ova will give origin? This, for the moment, is impossible to decide. It will be for ulterior researches to answer this grave and important question, the solution of which is no doubt reserved for the zoological station of Villafranca, the only spot where *Anchinia rubra* has been observed.

The individuals which have attained sexual maturity are very easily detached from the stolon, as may be often enough observed in specimens kept in captivity. Is this the case also in a state of freedom? This is difficult to say with any certainty, although the analogy with *Doliolum* renders it probable. In any case, whether the adult *Anchinie* become immediately detached or remain attached for a certain time to the stolon, it is certain that their existence cannot be of long duration. The two surfaces in contact, the extremity of the peduncle and the corresponding projection belonging to the stolon, are only in apposition without intimate union; and their adhesion is too feeble to resist the movement of the waves very long. Now, as the *Anchinie* do not present any organs adapted for pelagic life, they must assuredly perish soon when they are detached from the stolon which sustains them. " life of the *Anchinie* must therefore be very short; they per- no doubt, after the deposition of the ova, as may be observed in the case of the *Salpæ*.

The buds of *Anchinia* must be regarded, like those of the *Salpæ* and *Doliolum*, as representatives of the sexual generation, and there must be an agamic generation which produces the stolon and gives origin to the buds.

All the facts revealed in the course of this investigation lead us to regard *Anchinia* as presenting affinities especially

with *Doliolum*; in this respect we agree completely with M. Grobben*; but we think that the change that he proposes of the name *Anchinia* into *Doliopsis* is premature. It would be more prudent to wait for researches upon the form of generation which produces the stolon, a form which is still absolutely unknown to us; this, however, is a gap which we hope will soon be supplied in consequence of the foundation of a scientific centre at Villafranca.

EXPLANATION OF PLATES I.-III.

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| <i>a.</i> Anus. | <i>g c.</i> Nervous ganglion (hollow portion). |
| <i>b.</i> Mouth. | <i>g n.</i> Nervous ganglion (central portion). |
| <i>br.</i> Branchia. | <i>i.</i> Intestine. |
| <i>c.</i> Large cells of the upper surface of the stolon. | <i>l i.</i> Limit of the lateral portion of the cloaca. |
| <i>c c.</i> General cavity. | <i>l m.</i> Limit of the median portion of the cloaca. |
| <i>cell.</i> Large cells of the interior of the posterior filament (fig. 9). | <i>l s.</i> Superior (small) expansion of the cloaca. |
| <i>cce.</i> Cæcum of the intestine (figs. 6 and 7). | <i>l v.</i> Vibratile line. |
| <i>cl.</i> Lateral part of the cloaca (inferior wing). | <i>m.</i> Cutaneous muscles. |
| <i>c m.</i> Median part of the cloaca. | <i>o.</i> Ovary. |
| <i>c p.</i> Cavity of the peduncle. | <i>os.</i> Excurrent aperture (fig. 1). |
| <i>c s.</i> Superior dilatation of the general cavity. | <i>ov.</i> Ova and ovules. |
| <i>e c.</i> Cellular envelope (fig. 9). | <i>p.</i> Point of contact of the median portion of the cloaca and the pharyngeal sac. |
| <i>en.</i> Endostyle. | <i>ph.</i> Pharyngeal sac. |
| <i>end.</i> Endoderm. | <i>pr.</i> Heart and pericardium. |
| <i>est.</i> Stomach. | <i>r.</i> Disseminated cells (kidney?). |
| <i>ex.</i> Ectoderm. | <i>sp.</i> Spiral organ. |
| <i>œ.</i> Œsophagus. | <i>tim.</i> Tunic. |
| <i>f.</i> Olfactory pit. | |
| <i>fb.</i> Fibrous envelope (fig. 9). | |

Fig. 1 (Pl. II.). Fragment of stolon bearing zooids of different degrees of development:—3, corresponding to the bud of figures 2 and 3; 4, corresponding to the bud of figure 4; 6-7, corresponding to a stage intermediate between figs. 6 and 7, and so on. Enlarged 20 diameters.

Fig. 2 (Pl. I.). First stage of gemmation, seen from the ventral surface.

Fig. 3. The same stage in profile.

Fig. 4. A more advanced stage.

Fig. 5. A still more advanced stage.

Fig. 6 (Pl. II.). The following stage: the branchial clofts begin to show themselves. $\times 90$ diam.

Fig. 7 (Pl. I.). A more advanced stage: the tissues have lost their embryonic character; and the creature presents a transparency like that of the adult. $\times 46$ diam.

* *Loc. cit.* p. 73.

Fig. 8 (Pl. III.). Adult. The letters *ls* and *cl* represent the superior and inferior expansions of the cloaca, expansions separated at the level of the letter *p*, where the median portion (*cm*) of the cloaca comes into contact with the pharyngeal sac. The line *li* represents the boundary of the lateral portion of the cloaca, and the line *lm* the boundary of its median part.

Fig. 9 (Pl. II.). Transverse section of the filament of the posterior extremity. *cell*, large granular cells contained in its interior; *ec*, transparent cells which form its superficial covering; *fb*, fibrous envelope; *m*, section of the muscles of the aperture, which are produced on the ventral side nearly to the extremity of the filament. $\times 150$ diam.

Fig. 10 (Pl. III.). Transverse section of the endostyle. $\times 250$ diam.

Fig. 11. Transverse section of an *Anchinia* at a stage a little more advanced than fig. 7 and at the level of the stomach. $\times 30$ diam.

II.—On the Mutual Relations of the *Bunotherian Mammalia*. By E. D. COPE*.

THE name *Bunotheria* was proposed by me for a series of *Mammalia* which resemble in most technical characters the *Edentata* and the *Rodentia*. That is, they agree with these orders in having small, nearly smooth, cerebral hemispheres, which leave the olfactory lobes and cerebellum entirely exposed, and in some instances the hemispheres do not cover the mesencephalum also. From the two orders in question, however, they are easily distinguished. Their enamel-covered teeth separate them from the *Edentata*, while the articulation of the lower jaw is different from that found in the *Rodentia*. It is a transverse ginglymus with a postglenoid process in the *Bunotheria*, as distinguished from the longitudinal groove, permitting antero-posterior motion, of the *Rodentia*.

Such a group as is thus characterized will include two existing groups recognized as orders—the *Prosimiæ* and the *Insectivora*. The latter group has always been a crux to systematists; and when we consider the skeleton alone, as from the standpoint of the palæontologist, the difficulty is not diminished. Various extinct types discovered in latter years, chiefly in the *Eocene* formations, have been additions to this intermediate series of forms, giving even closer relations with the orders already adjacent, *i. e.* the *Edentata*, the *Rodentia*, the *Prosimiæ*, and the *Carnivora*. As is known, the groups corresponding to these orders have been named respectively

* From the 'Proceedings of the Academy of Natural Sciences of Philadelphia' for 1883, pp. 77–83.

the Tæniodonta, Tillodonta, Mesodonta, and Creodonta. With great apparent diversity, these suborders show unmistakable gradations into each other and the two recent orders already mentioned. As such I may mention *Psittacotherium*, which relates the Tæniodonta and Tillodonta, *Esthonyx*, which relates the Tillodonta with nearly all the other suborders, *Achænodon*, which connects Creodonta and Mesodonta, and *Cynodontomys*, which may be Mesodont or Prosimian. Then the existing *Chiromys* most certainly connects Tillodonta and Prosimiæ.

My original definitions of the suborders of the Mesodonta, given in vol. ii. of the U.S. Geological Survey under Capt. G. M. Wheeler, p. 85, omitted the Prosimiæ, and embraced a number of characters whose significance must be reexamined. Thus it is impossible to characterize the Creodonta as lacking a trochlear groove of the astragalus, in view of the form of that element in *Mesonyx* and *Miochenus*, where the groove is more or less distinct. It is impossible to distinguish the Insectivora from the Creodonta by the deficiency of canine and large development of incisor teeth. In *Rhynchocyon* the canines are large and the superior incisors wanting, while in *Centetes* the arrangement of these teeth is precisely as in the Creodonta. As to the large *Achænodon* and other Arctocyonidæ, I find no characters whatever to distinguish them from the generally small Mesodonta.

In view of these inconsistencies I have reexamined the subject, and find the following definitions to be more nearly coincident with the natural boundaries of the divisions of this large order. The importance of the character of the tritubercular superior molar has recently impressed me (see 'Proceedings of the Academy,' 1883, p. 56), as it had previously of the Prof. Gill. This zoologist has already distinguished two divisions of the Insectivora (without the Galeopithecidæ) by the forms of the superior molar teeth. The first possesses quadritubercular molars above, the second tritubercular. That these types represent important stages in the development of the molar dentition I have no doubt. These characters far outweigh in importance those expressing the forms of the skull, matters of proportion only, with which a few systematists unnecessarily overload their diagnoses. Such characters are of little more than specific value, and serve to obscure the mind of the inquirer for a true analysis. They may be used empirically, it is true, to determine relationships when the diagnostic parts are wanting.

I propose to transfer the Insectivora with tritubercular superior molars to the Creodonta, in spite of the fact that some

of them (*Mythomys*, *Solenodon*, *Chrysochloris*) have but weakly developed canine teeth, and *Chrysochloris* has large incisors. As an extreme form *Esthonyx* will follow, standing next the Tillodonta. It will then be necessary to transfer the Arctocytonidæ and all the Mesodonta to the Insectivora, where they will find affinity with the Tupæidæ. These have well-developed canines and small incisors, as in the extinct groups named. The Chiromyidæ must be distinguished from all the other suborders, on account of its rodent-like incisors combined with its lemur-like feet.

The characters of the six suborders will then be as follows:—

- | | |
|--|------------------------------|
| I. Incisor teeth growing from persistent pulps. | |
| Canines also growing from less persistent pulps, agreeing with external incisors in having molariform crowns | I. <i>Taniodonta</i> . |
| Canines rudimental or wanting; hallux not opposable | II. <i>Tillodonta</i> . |
| Canines none; hallux opposable | III. <i>Amblytonioidea</i> . |
| II. Incisor teeth not growing from persistent pulps. | |
| Superior true molars quadrituberculate; hallux opposable | IV. <i>Prosimia</i> . |
| Superior true molars quadrituberculate; hallux not opposable | V. <i>Insectivora</i> . |
| Superior true molars trituberculate or bituberculate*; hallux not opposable | VI. <i>Creodonta</i> . |

While the above scheme defines the groups exactly and, so far as can now be ascertained, naturally, I do not doubt that future research among the extinct forms will add much necessary information which we do not now possess. It is possible that the group I called Mesodonta may yet be distinguished from the Insectivora by characters yet unknown. But I cannot admit any affinity between this group and any form of "Pachyderms," as suggested by Filhol, or of Suillines, as believed by Lydekker†. Such suppositions are in direct opposition to what we know of the phylogeny of the Mammalia. These views are apparently suggested by the Bunodont type of teeth found in various Mesodonta; but that

* The internal tubercle is wanting in the last two superior molars in *Hyænodon*. This genus, of which the osteology remains largely unknown, has been stated by Gervais to possess a brain of higher type than the Creodonta. Prof. Scott, of Princeton, however, is of the opinion that this determination is erroneous, and that *Hyænodon* is a true Creodont in this and other respects. If so, the genus will perhaps enter the Amblytonidæ.

† Memoirs Geological Survey of India, ser. x. 1883, p. 145.

character gives little ground for systematic determination among Eocene Mammalia, and has deceived palæontologists from the days of Cuvier to the present time. The only connecting-point where there may be doubt as to the ungulate or unguiculate type of a mammal is the family Peripitychidæ, of the suborder Condylarthra. The suborder Hyracoidea may furnish another index of convergence.

The families included in these suborders will be the following:—

TÆNIODONTA. *Calamodontidæ*, *Ectoganidæ*.

TILLODONTA. *Tillotheriidæ*.

DAUBENTONIOIDEA. *Chiromyidæ*.

PROSIMIÆ. *Tarsiidæ*, (?) *Anaptomorphidæ*, (?) *Mixodectidæ*, *Lemuridæ*.

INSECTIVORA. *Soricidæ*, *Erinaceidæ*, *Macroscelidæ*, *Tupaidæ*, *Adapidæ**, *Arctocyoniidæ*.

CREODONTA. *Talpidæ*, *Chrysochlorididæ*, *Esthonychidæ*, *Centetidæ* (= *Leptictidæ* olim), *Oxyenidæ*, *Miacidæ*, *Amblyctonidæ*, *Mesonychidæ*.

I at one time called this order by the name Insectivora, a course which some zoologists may prefer. But a name should as nearly as possible adhere to a group to which it was first applied, and whose definition has become currently associated with it. Such an application is correct in fact, and is a material aid to the memory. There are various precedents for the adoption of a new general term for a group composed of subordinate divisions which have themselves already received names.

In order to determine the number of internal tubercles in some of the Insectivora, so as to ascertain the affinities of some questionable genera, it is first necessary to examine the homologies of the cusps of the molar teeth. The opossums are characterized by the presence of three longitudinal series of tubercles on the superior molar. The homologies of these cusps are rendered clear by the character presented by the fourth superior premolar, where the anterior intermediate is wanting. The external cusps are really such, and are not developed from a cingulum external to the true external cusps,

* Two species of *Pelycothus* must be removed from this genus and family and be placed in the Creodonta with *Miolanens*. They are the *P. pelvidens* and *P. angulatus*, which have the posterior inner tubercle of the superior molars a mere projection of the cingulum. I place them in a new genus, which differs from *Miolanens* in the possession of an internal cusp of the fourth inferior premolar, under the name of *Chriacus*, type *C. pelvidens*.

as appears at first sight to be the case with such animals as the Talpidæ. The intermediate cusps are really such, although the posterior looks like the apex of a V-shaped external cusp. In *Peratherium* the external cusps are smaller than in *Didelphys*, and the intermediate V's so much better developed that the type is much like that of the Talpidæ, to whose neighbourhood I originally referred it.

This leads to a consideration of the question of the homologies of the cusps in the genera of the old order of Insectivora proper, and of the Creodonta. Mr. St. George Mivart has briefly discussed the question, so far as relates to the former group*. He commences with the primitive quadrituberculate type presented by *Gymnura* and *Erinaceus*, and believes that the external cusps occupy a successively more and more internal position till they come to be represented by the apices of well-developed V's, as in the ungulate types. The V's are well developed in several families; and in *Chrysochloris* the two V's are supposed to be united and to constitute almost the entire apex of the crown, while in *Centetes* the same kind of V forms a still larger part of the crown.

I believe that these conclusions must be modified, in the light of the characters of various extinct genera and of the genus *Didelphys*. In the first place, there is an inherent improbability in the supposition that the external V's of the superior molars of the Insectivora have had the same origin as those of the Ungulata. The movements of the jaws in the two groups are different, the one being vertical, the other partially lateral. In the one, acute apices are demanded; in the other, grinding faces and edges. We have corresponding V's in the inferior dental series, and we regard those as produced by the connexion of alternating cusps by oblique ridges. In homologizing the superior cusps we have as elements two external, two intermediate, and two internal cusps. The first are opposite the external roots, and the anterior internal is opposite the internal root.

First, as regards *Centetes* and *Chrysochloris*. Besides the strained character of the hypothesis that supposes the V-shaped summit of the crown to represent two V's fused together, there is good evidence obtainable in support of the belief that the triangle in question is the usual one presented by the Creodonta.

This clearly consists of the two external and the anterior internal cusps united by angular ridges. The form is quite the same as in *Leptictis* and *Ictops*, and nearly that of *Delta-*

* Journal of Anatomy and Physiology, ii. p. 138, figures.

therium, where the external cusps are present. *Centetes* and *Chrysochloris* only differ from these in that the internal cusps are wanting. In addition, the latter genus presents a rudiment of the posterior inner tubercle, as is seen in *Deltatherium*. An explanation similar to this is admitted by Mr. Mivart to apply to the cusps of the inferior molar of *Centetes*. It remains to ascertain whether the cusp in this genus, *Chrysochloris*, &c. represents an intermediate or not.

Secondly, as regards the Talpidæ and Soricidæ, where the external V's are well marked. If we examine the external cusps in the genus *Didelphys*, we find that the posterior one becomes gradually more anterior in its position, until on the second true molar it stands largely above the interspace between the roots instead of over the posterior root. It will also be seen that the anterior intermediate tubercle is distinct and of insignificant proportions, while the posterior intermediate is large and is related to the posterior external as is the apex of a V to its anterior base. In this arrangement I conceive that we have an explanation of the V's of the Talpidæ and Soricidæ. The first true molar of *Scalops* is a good deal like that of *Didelphys*; but the anterior cusp is larger and there is no anterior intermediate cusp, while the posterior external is of reduced size. The posterior V is better developed than in *Didelphys* but is composed, in the same way, of a posterior intermediate cusp, and a posterior external with a posterior heel. These are united by stronger ridges in *Scalops*, *Condylura*, and *Blarina* than in *Didelphys*. On the second true molar in *Scalops* a V represents the anterior external cusp of the first true molar. Whether this V has a constitution like the posterior one, *i. e.* is composed of external and intermediate cusps joined, is difficult to determine; but it is probably so constituted. It seems to be pretty clearly the case in *Blarina*, where the fourth premolar and first true molar may be compared, with a resulting demonstration of the correctness of this view. In *Condylura* the V's have become more developed and the external cusps reduced, so that the analysis is more difficult.

This interpretation applied to *Urotrichus* and *Galeopithecus* gives them quadrituberculate molars, not trituberculate, as determined by Mivart. *Mystomys* is tritubercular. The intermediate tubercles are present, but are imperfectly connected with the external, so that V's are not developed (*vide* figures of Mivart and Allman). This genus offers as much confirmation of the homology here proposed as do the opossums; but it differs from the latter in having the anterior intermediate tubercle the larger, instead of the posterior. *Mystomys* and

Solenodon also confirm my determination of the homologies in *Centetes**.

In conclusion I give the following synoptic view of the constitution of the superior molar teeth in various genera of the Bunotheria.

CUSPS PRESENT.					
External, intermediate, two internal.	External, no intermediate, two internal.	External, intermediate, one internal.	External, no intermediate, one internal.	No external, no intermediate, two internal.	No external, no intermediate, one internal.
Adapidae.	Gymnura.	Mystomyidae.	Mesonyx.	Chrysochloris (2nd internal rudimentary).	Centetes.
Tupaiidae. (Galeopithecidae. Soricidae.	Erinaceus. Macrocelididae.	Mioclaenus. Miacis. Talpidæ.	Leptictis. Stypolophus. Oxyana.	Solenodon (ditto).	
Urotrichus.		(Didelphyæ.) (Canis.)	Chriacus. Deltatherium. Esthonyx. (2nd internal rudimentary).		

III.—*On the Microscopic Structure of thin Slices of Fossil Calcispongiæ.* By H. J. CARTER, F.R.S. &c.

IN the "P.S." which I hastily added to my last "Observations on the so-called 'Farringdon Sponges' (Calcispongiæ, Zittel)," it is stated that Dr. Harvey B. Holl had kindly sent me four slides, testifying respectively to two facts, viz. 1st, that the spiculation of *Verticillites anastomans* was that of a Calcisponge, to me "precisely like and almost identical in size" with that of *Grantia compressa*; and 2nd, that it was confronted by a crust of pinlike spicules with their heads outwards; and at the conclusion, that I had *not* seen the latter in my specimens of *Verticillites anastomans* from Farringdon in Berkshire.

Wishing to confirm this, I obtained through Dr. Holl's kindness his entire specimen, and having made two or three

* This view was first advanced by the writer in the Annual Report U.S. Geol. Surv. Terrs. 1873-74, p. 472.

slides from it, found in all what I have stated; while, seeing that the specimen was identical with one of my own from Farringdon, I did the same with this with the same result; but when thus engaged I saw that I had specimens of *another* form in my collection, and that this also presented the pinlike spicules. It was then evident that there were *two*, viz. Dr. Holl's and another, and that they chiefly differed in the form of the siphonal cloaca which passes through the centre of each septum, like that of an *Orthoceras*, only with the convexity of the septa reversed (that is, directed upwards or outwards) in *Verticillites*. In Dr. Holl's specimen this passage is reduced to a margined circular hole of intercommunication in the septa which separate the chambers; while in the other form it is a continuous tube or cylinder communicating with the chambers respectively by holes in its *sides*, which thus, through this canal, establish a communication with the exterior.

On reference to Dr. Gustav Steinmann's figures ("Pharetronen-Studien," Neues Jahrbuch f. Mineral. Geol. u. Paläontologie, 1882, ii. Bd. Taf. vi. u. viii. figs. 5, 6 u. 1 respectively) I see that Dr. Holl's species has been called "*helvetica*" by De Loriol (Urgonien infér. de Landeron, p. 65, t. v. figs. 4-11); while the other form had long since received the name of "*Verticillipora* (*Verticillites*, Defr.) *anastomans*" from Murchison ('Wonders of Geology,' p. 636, fig. 3, &c.).

The pinlike spicules, however, are present in *both*, and arranged in the manner of a funnel, with the spout inwards or continuous with each external aperture of the radial canals, as may be proved by making a horizontal and vertical section of the wall respectively, when the full length of the pinlike spicules is seen in the former sloping inwards towards the canal, and their truncated ends in a circle surrounded by the triradiates in the latter, while by making one horizontally through the septum and the wall *together* both may be seen at once. The pin spicules, like the triradiates, are dissolved by diluted nitric acid, although generally preserved in form when that of the triradiates has almost entirely disappeared. It is very probable that Dr. Holl's specimen came from the same neighbourhood as my own; but, be this as it may, it would be desirable to ascertain if the pinlike spicules are absent in the species from the Jura and elsewhere out of England, as they are in Dr. Hinde's *Verticillites* *D'Orbigny*, which came from the Upper Greensand at Warminster in Wiltshire, within twenty-four miles of Farringdon.

The next point to which I would direct attention is the change which takes place in the spiculation of the Calcispongiae during fossilization, to which I have also hastily alluded

in the following "footnote" to my above-mentioned paper in the 'Annals,' viz. :—

"Can it be possible after all, that this concentric lamination is mineral and not organic—that is, that the calcareous layers are but a reproduction in *form* of the original spicules, which, during fossilization, have become dissolved and furnished this solution for the new structure, as often seen in the chalcodonization of the vitreous sponges, or as agatoid layers round a grain of extraneous matter? The examination of another slice of my specimen of *Sestrostomella* from the Jura strongly inclines me to this view" ('Annals,' ser. 5, vol. xi. p. 35).

Thus influenced, I lost no time in endeavouring to confirm the inference by grinding down slices of several species of fossil Calcispongiæ to a minimum of at least 1-500th of an inch, or semitransparency, viz. *Verticillites anastomans* and *helvetica*, *Peronella dumosa*, *Oculospongia dilatata*, *Elastomostoma acutimargo*, and two or three others, when I came to the following conclusions :—

1. That during fossilization, the organic matter of the spicule disappearing, the mineral matter, thus deprived of its cement, is set free.

2. That while this is taking place the forms of the spicules are more or less destroyed and the mineral matter more or less passes into solution.

3. That the forms of the spicules thus more or less destroyed run into each other so as to assume shapes totally different from what they were originally, while the rest of the calcareous material in a state of solution becomes deposited in the form of fibre composed of one or more concentric layers enclosing the lines of spicules.

4. That although the slice when reduced to extreme thinness may present no distinct tri- or quadriradiates, yet one, or more *perfect* ones may have come into view during the latter part of the reduction, when, after every two or three strokes of the grinding, the slice should be transferred to the field of the microscope, lest the spicule be rubbed off altogether. Hence the advantage of grinding down the slice one's self, otherwise such important facts might pass unnoticed.

5. That if the tri- or quadriradiate of a Calcisponge *ent. par.* is thus seen, this should be sufficient to prove the nature of the fossil, although the next stroke of the grinding may destroy it, which is often the case.

Observations.

It is, however, the running together of the lines of the

original tri- or quadriradiate spicules which leads, in all instances that I have examined, to the branched, forked, and other forms that resemble the spiculation of a Lithistid sponge, especially after the slice has been reduced to the lowest degree (that is, to semitransparency). Hence, whenever I have been so fortunate as to see even one undoubted tri- or quadriradiate of a Calcisponge, although, as before stated, it may have disappeared in the subsequent grinding, I have felt as convinced that the fossil was a Calcisponge as that the fantastic forms which accompanied it were spurious; so that now when I come to a perfect tri- or quadriradiate of the kind mentioned, I stop grinding and mount the specimen for preservation and more deliberate examination.

*Process of Grinding down a Slice of a Calcareous Fossil
for Microscopic Examination.*

Take about one part of half-dry Canada balsam, and place it on the centre of a glass slide; heat it until melted over a spirit-lamp with about half an inch vertical flame, moving the slide backwards and forwards to prevent the latter from cracking; add two parts of shellac; and when the whole has bubbled up, stir it with the point of a needle so as to mix well, and spread it altogether over a little more of the glass than the size of the slice to be reduced.

Previous to this, cut off with a watch-spring or very fine saw fixed in an iron bow-frame (all of which may be obtained from an ironmonger at a very small charge) the slice to be ground down; and if there be much siliceous matter in the fossil, the saw (which is very cheap) may be sacrificed by the addition of emery powder and water to the groove, as this accelerates the cutting. (Of course where a machine with horizontal turning-wheel is possessed, such as is used for cutting siliceous fossils, flint, &c., this is the quickest and most economical way to obtain the "slice.")

Having thus obtained it, so far prepared, rub one side (viz. that to be examined) down to *scratchless smoothness* on a schoolboy's slate or very fine honestone with level surface, to effect which it is absolutely necessary that all the materials should be entirely freed by washing from every particle of emery or siliceous mineral that may happen to be present; otherwise the calcareous surface will become almost irremediably furrowed.

Next dry the slice on a tin or paper tray placed inside the fender by the fire, where it can remain until the next part of the process is completed.

Now remelt the material on the glass slide as before; and when sufficiently fluidified to present a uniformly level surface (but *not burnt*, for this would destroy the tenacity of the cement and thus give it a crispness which, by cracking, would defeat all attempts at further reduction), quickly transfer the warmed slice (which should now be close at hand) to it, while with a little pressure the "*smoothed*" surface is brought into direct contact with that of the glass. Thus let it remain on the table where this is done until the glass feels cold to the touch.

After this reduce the slice to the thinness of a wafer over a very fine vertical rotating grinding-stone, or on a copper plate with emery powder and water, horizontally.

Now wash it well in water, and, placing the slide on a piece of buckskin leather spread on the table or over a level surface (to keep it from slipping) with the slice uppermost, continue the reduction in water with a piece of very fine siliceous limestone, that may be obtained from a statuary, of a convenient form (that is, one which will admit of the surface of the slice coming into direct and continuous contact with that of the limestone), with which it should be horizontally rubbed until reduced to the required thinness, which must be ascertained by repeatedly transferring the slice to the field of the microscope with an inch object-glass and high ocular. The nearer this thinness is approached the oftener this transfer should be made, washing the slice by dipping the slide into a bowl of water each time that it is examined.

When sufficiently reduced, wash the slide as before, and stand it up to drain until the slice is perfectly dry. Then cover with benzol, followed by balsam and thin glass, for preservation and more deliberate examination.

I make no apology for introducing these remarks, as the "process," although open to criticism and improvement no doubt, answers the purpose; and while inexperienced I myself should have been very glad of such aid. Dr. Holl suggested to me the use of shellac, which is the most valuable hint that I have received.

IV.—*On the Presence of Starch-granules in the Ovum of the Marine Sponges, and on the Ovigerous Layer of Suberites domuncula, Nardo.* By H. J. CARTER, F.R.S. &c.

It was but a short time since that I pointed out another instance of a structure like that of the cellular tissue of plants,

situated around the statoblast of freshwater sponges ('Annals,' 1882, vol. x. p. 367); the presence of starch-granules had been described in 1856, although not figured until 1859; and now I have to announce the latter also in the ovum of the marine sponges.

As this was brought to my notice by cutting up a fragment of the ovigerous layer of *Suberites domuncula* into small pieces, when, by pressure, both oil-globules and starch-granules made their appearance among the granular contents of the ova, I will particularly describe this layer before comparing these ova with those of other sponges.

Familiar to naturalists as *Suberites domuncula*, Nardo, ap. Schmidt, 1862 (Spong. Adriatisch.), = *Hymeniacidon suberea*, Bowerbank, 1866 (Mon. Brit. Spong. vol. ii. p. 200), has been for many years past, viz. from Aldrovandus, at the beginning of the 17th century (Johnston, Brit. Spong. p. 142), down to the present time, although not recognized as a *sponge* until Col. Montagu described it as such from specimens dredged on the coast of Devonshire circa 1812 (Werner. Mem. Edin. 1818, vol. ii. p. 100), no one appears to have noticed the striking manner in which its ova are deposited in a layer on that part of the hard object (generally a dead shell) over which it may have grown.

On the 6th January 1870, after a storm, I picked up on this beach (Budleigh-Salterton, South Devon) two specimens, and on the 4th September 1877 upwards of 150 were brought to me from the dredgings of a "trawler" about 20 miles off this shore, all of which had grown on dead shells of a similar kind, viz. *Turritella* and small *Buccinum*, tenanted either by a hermit crab (*Pagurus*) or annelid. All, or as many as I have examined, present the same kind of ovigerous layer, in which all the ova are in the same stage of development; so that we may infer, from the dates above mentioned and what will be stated hereafter, that throughout the year these sponges, if containing a dead shell or any similarly hard object, will have upon it a similar ovigerous layer.

Like most of its kind, too, *Suberites domuncula* not only grows over the dead shell, but as it grows encloses a large quantity of the fine detritus of the sea-bed in which it may have lived; so that it is impossible to free the smallest portion from this foreign material, and it is on this account equally impossible to obtain a satisfactory view of the finer elements of which the sarcodic substance of the sponge itself is composed.

Each specimen appears to be but a single individual ("person," Hæckel), as each has only a single ragged vent

situated on the most pendent or prominent part, which is the outlet of a well-developed excretory canal-system, whose branches pervade the extremely fine and compact structure of which the sponge is otherwise composed. The pinlike spicules &c. and the ovigerous layer that I am about to describe are also particularly evident; but as the sponge generally has been heretofore repeatedly noticed with the exception of this layer, I shall henceforth confine myself to a description of the latter only.

If a vertical section of one of these specimens be made, so that the incision may fall perpendicularly and longitudinally on the shell over which the sponge may have grown, and the two portions forcibly separated from each other, so as to expose the shell beneath (say a *Turritella* about $1\frac{1}{2}$ inch long), a yellowish chitinous layer composed of ova closely packed together (not unlike the nidamental layer of a mollusk) will be left upon the shell, corresponding in extent to the amount of the shell covered by the sponge, whether this be a part or the whole, and adhering so strongly that the whole of the sponge-substance may be washed off with a brush without disturbing the attachment (fig. 3). On the other hand, supposing that the sponge, as is commonly the case, be attached to the whole length of the *Turritella* and the specimen (having been preserved in a wet state) is put into dilute nitric acid, the shell part will be entirely dissolved away, leaving the ovigerous layer in this instance attached to the sponge, when a similar section with a sharp thin knife may be made to pass through both the sponge and the ovigerous layer together; and thus, by examining the object in water under a microscope, the thickness and structure of the latter may be easily ascertained.

The ovigerous layer may then be observed to be composed of a yellowish tough chitinous stratum of ova in juxtaposition, but only one ovum deep or thick (fig. 2), of which the part that was in contact with the shell is flat, thin, and even (fig. 2, *b*), but that towards the sponge thick and granulated by the convexities of the layer of ovarian capsules, which, from being compressed together, vary slightly in height, size, and shape, so that, although generally the stratum or ovigerous layer is only one 200th of an inch thick, the thickness towards the sponge is so far rendered irregular (fig. 2, *a*), while the horizontal diameter of the ova when viewed in a flat position on the sponge side is found to vary from the 180th to the 90th of an inch (fig. 3); hence the ovum, being flat below, convex above, and rendered more or less polygonal laterally by horizontal compression, fails to

present that spherical form which it would do if, as in other cases, it had been isolated in the midst of the sponge-tissue.

Taking the elements of the ovum one by one from without inwards, it will be found to consist of a thick chitinous capsule followed by a delicate membrane filled with the yelk. The capsule, as before stated, is convex towards the sponge, flat towards the shell, and polygonal laterally, presenting on its convexity a great number of minute circular granules or points arranged more or less hexagonally, more or less projecting beyond the surface, often possessing a punctum in the centre, and always connected with each other by a fold of the surface, so that it presents under high microscopic power a reticulated appearance (figs. 3, *a*, and 4). This part of the capsule is very thick when compared with the side towards the shell, being composed of five or more chitinous layers, amounting in all to 1-3000th inch, while the flat side hardly amounts to more than one of these layers. Interiorly it is smooth, where it is in contact with the delicate membrane investing the yelk, and appears to be uniformly closed on all sides; so that no aperture whatever could be detected in it.

The yelk, on the other hand, surrounded by this "delicate membrane," which is hardly demonstrable from its transparency and thinness, consists of spherical refractive granules about 1-12000th inch in diameter, among which are a great many oil-globules and starch-granules, the latter of a greyish-white colour, more or less oval in form, flat, and presenting a crack-like translucency in the centre, varying in size under 1-600th inch in diameter and becoming of the usual opaque blue colour under the influence of iodine, when they strikingly contrast with the whiteness of the yelk-granules generally, which do not become so coloured.

Such is the composition of this ovigerous layer, and such the characters of the contents of the ova in every instance that I have examined; so that it may fairly be assumed that under these circumstances none ever get beyond the granulation of the yelk in this position, whatever they may do afterwards when impregnation and the duplicative subdivision of the yelk destroys the individuality of the yelk-granules and leads on to the development of the embryo—a state which I have not witnessed, nor do I know where to find; but as the ovigerous layer is only to be seen over the surface of the hard objects enclosed by the Suberite so long as they exist, and no trace of such a layer or any ova can be discovered after the shell has disappeared, even when its mould still remains empty, which is often the case (as proved by a specimen where the

upper half of the *Turritella* on which the sponge had grown remains with the ovigerous layer still on it, while the lower part has disappeared and left not a trace of ova or the ovigerous layer behind, where both originally existed (fig. 1), and in another, where the original shell has passed away and a smaller one has been enclosed, apparently for the purpose of receiving a new ovigerous layer, it seems not impossible that impregnation and the further development of the ovum may take place with the disappearance of the shell, when the embryo at least could easily escape through that part of the capsule which was in contact with it, and which I have stated to be so extremely thin (fig. 2, b).

Let us now turn our attention for a few moments to the ova of other marine sponges, to see how far they agree with those of *Suberites domuncula*; and selecting *Isodictya simulans*, Bk., for this purpose out of several ova-bearing ones that I have, preserved in spirit, the ova will be found to be congregated in the sponge towards the base or oldest part, but not attached to the rock on which the sponge may have grown, as in *Suberites domuncula*. While thus isolated they present a spherical form so long as the yelk has not passed into the fully developed embryo; but when this is completed the embryo bursts through the delicate capsule which enclosed it, and then assumes the form of a conical shot or elongated cone with a little tuft at the obtuse end (the long cilia). Under the form or spherical condition, in my specimen, the grumous or clotted state of the contents and presence of spicules already show that the originally granular state of the yelk has been transformed through duplicate subdivision with its consequence into the coming embryo, and thus the presence of starch although evident under the use of iodine, is now very trifling, showing that in the egg of the Suberite, as in the seed of plants, it is abundant at the commencement and disappears in the usual way under germination.

The same observations apply to the ova of *Halysarcea laris*, *Aplysina corneostellata* (*Darwinella aurea*), *Eusperia*, or *Halichondria sanguinea*, Johnst., so that we here see the animal nature evinced in spite of the resemblance of the ova of sponges to the seed of plants; for while the sponge-embryo develops a root for fixation only, and a superstructure for supporting organisms that take in crude material for food, that of plants develops a root for nutrition as well as fixation and a leafy superstructure, viz. the "plumule," which grows by *endosmosis* through the spongioles at the ends of the radicles.

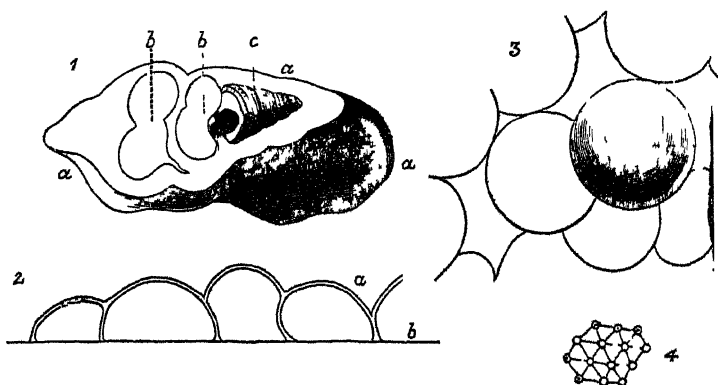
Having already gone into the subject of impregnation in

the Sponges ('Annals,' 1882, vol. x. p. 364), I have only to add here that, accompanying the ova of *Aplysina corneostellata* especially, which are about 1-120th inch in diameter, there are in my specimen many smaller spherical bodies averaging only 1-360th inch, which in size do not appear to be a second set of ova, although when dyed with aniline red they all (both ova and these bodies) become equally tinged and much more so than the other parts; but being respectively surrounded by a capsule formed of granuliferous cells, it is almost impossible to say what appearance their respective contents otherwise present. I think I can see the same also among the ova of *Isodictya simulans*, where the granulated appearance of *their* contents is not obscured by a capsule of this kind; and certainly in a thin slice of *Grantia compressa*, whose spongozoa in the living state were successfully fed with indigo, so that all the other elements (viz. larva, ova, and these granuliferous cells) remain *uncoloured*, while the blue spongozoa mark out the ampullaceous sacs with a sharpness which prevents all confusion; but whether these granuliferous bodies were spermatie or not I am unable to decide. It may not be unworthy of remark here, that while examining the freshwater sponges of Bombay, in 1856, I noticed granuliferous cells which seemed to me to be spermatie, and thus described them "provisionally" under the head of "spermatozooids" ('Annals,' 1856, vol. xviii. p. 227).

Lastly, another instance of the presence of spermatozoa in sponges has lately been added by Dr. N. Poléjaeff, of the University of Gratz, which was obtained from an examination of *Sycandra raphanus*, Häckel, in the *living* state, by making very thin slices and examining them under a high microscopic power, afterwards followed by the application of osmic acid and alum-carminc, to render the tail or cilium more evident ("Ueber das Sperma und die Spermatogenese bei *Sycandra raphanus*, Häckel," Separat-Abdruck aus dem lxxxvi. Bande der Sitzb. der k. Akad. Wissensch. 1 Abth. Nov. Heft, Jahrg. 1882; read 16th Nov. 1882). But still there is no character given to the spermatie cell, as I have before noticed, by which it may be satisfactorily recognized by the inexperienced student, if, indeed, there be any such; and, so far as the *granulation* goes, it is as conjectural to me now as it was in 1856.

Allusion is made (p. 4) to my also conjectural figures of the spermatozoon in *Grantia compressa* ('Annals,' vol. xiv. p. 108, pl. x. figs. 21-23), which are so much more like the monociliated cells of the larva at a very early period than the spermatozoa of *Sycandra raphanus* represented by Dr. Poléjaeff, that I am now more inclined than ever to regard them as such.

The ova of sponges in colour generally follow that of the parent sponges themselves, especially towards maturity, when this becomes more intense, and thus they contrast strongly with the rest of the substance. The ovabearing specimens which I possess are:—*Halisarca lobularis*, obtained from this shore in July 1874; *Aplysina corneostellata*, from Vigo Bay, by Saville Kent, F.L.S. &c., June 1870; *Isodictya simulans*, from this shore (here the ovum is white), July 1874 (at this time also I found *Esperia* and *Halichondria sanguinea* in an ovabearing state, but did not preserve any of them); lastly, *Grantia compressa*, from this shore, May 1871, viz. those individuals which were successfully fed with indigo. Dr. Poléjaeff does not give the date of his observing the spermatozoa in *Sycandra raphanus*, although, from his paper having been read in the month of November, it may be inferred that this took place during the preceding summer. It is desirable to add the dates of such observations, because they may not only be a guide to others, but finally fix the period of this mode of reproduction in the species.



EXPLANATION OF THE WOODCUTS.

- Fig. 1.** *Suberites domuncula*, Nardo, natural size. Section of, showing:—*a a a*, sponge; *b b*, cavities left by the lower whorls of the enclosed shell (*Turritella*), which have disappeared; *c*, remaining portion of the shell, covered with the ovigerous layer.
- Fig. 2.** The same. Fragment of vertical section of ovigerous layer showing:—*a*, convexities of capsules towards the sponge; *b* flat membrane covering the shell. Scale about 1-24th to 1-1800th inch.
- Fig. 3.** The same. Fragment of ovigerous layer viewed from the sponge side, showing the juxtaposition of the ova: *a*, ovum, on which the granulation of the surface is depicted. Same scale.
- Fig. 4.** The same. Fragment of the granulated surface, much magnified. Scale about 1-24th to 1-6000th inch.

V.—*The Microscopic Sexual Characteristics of the American, Portuguese, and Common Edible Oyster of Europe compared.* By JOHN A. RYDER*.

IN the issue of 'Forest and Stream' of November 30 just past, in an article by the writer, page 351, middle column, it is remarked:—"I regard Davaine's observations upon the histology of the reproductive organs [of the European oyster] as of little value, being made before the introduction of improved methods of investigation. His figures of the finer structural details have apparently been made from crushed fragments." In passing this judgment upon Dr. Davaine's work I have been severer than the state of the case demanded, as will be seen in the sequel, though I do not yet admit that his methods of research were what they should have been, for until now we have had no adequate description of the structures in question. Until recently I have maintained with reservations that the sexes in the European oyster were probably separate, as in the American; more recent investigation with more refined methods have proved to me that in this I was in error. In my article in 'Forest and Stream' I also took occasion to refer to a statement in Gegenbaur's 'Elements of Comparative Anatomy,' English edition, p. 380, where he says:—"In the oysters we find an intermediate step toward a separation of the sexes, inasmuch as these organs are not active at the same time in the same individual; but the male and female organs alternately so." The writer, in commenting upon the above, then wrote, "This quotation tacitly admits the unisexuality of the European oyster, to which it evidently refers. The last part of the remark, however, is founded upon the slenderest kind of evidence—in fact, upon no evidence except a surmise, as such an alternate activity of the two parts is improbable [for obvious reasons]; besides, it is not possible to demonstrate such an alternation of sexual activity in the same individual. As every one knows, the soft parts of an oyster cannot be examined without opening the shell, which necessarily makes the needed second observation to confirm this alleged alternation of sexual activity a physical impossibility." I am now in a position to go still further, and to assert that the first part of the quotation from Gegenbaur is also erroneous, because we may find both eggs and spermatozoa in the same follicle at the same time.

* From the 'Bulletin of the United States Fish Commission,' March 14, 1888, pp. 205-215.

What, then, is the true state of the case? This query we propose answering; but before we set out it will be necessary to give some account of the methods of investigation used in order to arrive at a definite conclusion. Thin sections of those portions of the animal in which the reproductive structures are lodged are of the first importance. After trying various methods, which were found for the most part unsatisfactory, the preparation of sections was finally conducted as follows:—After the soft parts were removed from the shell they were thrown into a chromic acid solution of from one to two per cent., in which they were allowed to remain for several days; and in some cases the hardening solution was even renewed. This was done in order that the hardening agent might act upon the whole of the soft parts and harden them throughout; unless the chromic acid is allowed some time to act upon the entire animal, it will not be uniformly hardened, the centre of the body remaining soft. After hardening, the animals should be thoroughly washed and soaked in water for a couple of days, to remove all traces of the acid before they are finally put into alcohol for permanent preservation. Hardened material so preserved will make good sections months afterwards.

Portions of the body-mass of different individuals should then be cut out; it is best to cut up the body into thick slices or blocks in a transverse direction, large enough to be conveniently held between the fingers. It was also found advisable to take such thick slices of the hardened body-mass from several individuals, since it was discovered that scarcely any two had the reproductive glands developed to exactly the same degree of maturity. This point is important, as it has enabled us to follow up the development of the reproductive organs in the connective tissue which invests them. After considerable experiment and disappointment in the effort to imbed these thick hardened slices so as to cut sections with the microtome, the method of imbedding was abandoned altogether. The thick blocks or slices were entirely freed from alcohol by soaking in water for a day, then removed, after drying them off as much as possible with blotting-paper or a soft linen cloth, to a thick solution of gum arabic, in which it is best to allow them to remain from twenty-four to forty-eight hours, so as to be thoroughly saturated. The superfluous gum may then be poured off and the blocks of tissue, soaked as they are with the gum, covered with strong alcohol. In twenty-four hours the blocks will be found hard enough to cut. The blocks of hardened tissue are simply held between the thumb and fore finger, and the sections made with a section

knife with the free hand. When cutting sections it is necessary to keep the knife well wetted with alcohol, so that the sections may readily slide off on the upperside of the blade. Water should not be used to wet the knife, as it would get on the block of tissue, dissolve the gum, soften the surface to be cut, and injure the succeeding sections. The sections are lifted from the knife as fast as cut, with a camel's hair pencil, and thrown into a dish of water, in which the gum will dissolve out in a few minutes. The sections are then ready to be stained; and in order to clearly differentiate the hermaphroditic character of the reproductive glands of *Ostrea edulis*, a special staining reagent must be used. The one which gives the best results and acts most quickly will be given here. Equal parts of dense alcoholic solutions of safranin red and methyl green* are poured together and diluted with about eight times their combined volumes of water, producing a dark purplish solution of about the colour of claret wine. Into this the sections may be thrown and allowed to remain until completely saturated with colour, or until they are opaque: they may remain in the staining-fluid from one hour to a day; but two or three hours is a sufficient length of time. When removed from the staining-fluid they are too deeply stained to be mounted at once, and must therefore be transferred to 95-per-cent. or absolute alcohol, and stirred about in it until the safranin red is no longer given off in clouds from the sections; but it is important to note that if the sections remain in the strong alcohol too long the whole of the safranin will be washed out. In order to prevent this, when it is seen that the section has acquired a rosy red hue, combined with a bluish-green tint in the parts stained by the methyl green, the object should at once be removed from the alcohol, thrown into oil of cloves and mounted in balsam or damar. The extraction of the superfluous colour requires from five to fifteen minutes, according to the thickness and character of the section, and should on no account be allowed to proceed too far; if it does, the peculiar and important staining-effect of the safranin is lost. As first pointed out by Flemming, it has the peculiar property of staining the nucleus and its contents while it may be totally removed from other parts of the cell; in fact, as in the oyster-egg, it may be entirely removed from the nucleus and left only in a part of the nucleolus. The methyl green, on the other hand, does not tend to stain the eggs, but rather the spermatozoa and the cells from which they are derived; and it is one of the most astounding facts known to histological

* These are both aniline colours; the first is hard to obtain, except from dealers in dyers' colours.

chemistry, that although both of these dyes, to begin with, are intimately mixed together in the staining-fluid, the different histological elements of the section exert some kind of selective power by which they absorb and hold mainly the one colour only. This peculiar property of the two colours, even when mixed together, enables one to distinctly map out the relations of the sexual elements in the reproductive follicles, the nuclei of the ovarian ova being stained red by the safranin, and the heads of the spermatozoa bluish green by the methyl green. The foregoing is mainly the method to which I have had recourse in working out the sexual characteristics of *Ostrea edulis*. Simpler staining-methods suffice in the case of *Ostrea virginica* and *Ostrea angulata*. A single colour used in staining sections of *O. edulis* is liable to lead to error, in consequence of the peculiar mode in which the spermatozoa are packed together in oblong clusters, which are often of about the size of the ovarian ova. This egg-like appearance of the masses of unripe spermatozoa in the follicles of the reproductive organs of the common oyster of Europe misled me when examining sections stained only with cosin or carmine. The monochromatic effect produced by one colour only gave no hint as to the real relations of ova and spermatozoa in the follicles until high powers were used with special manipulation of the light.

The characteristics of the reproductive organs of *Ostrea edulis*, *O. virginica*, and *O. angulata* are sufficiently marked to be very precisely described and figured, so as to enable any person to appreciate the differences, especially between the first and the last two. *O. edulis* is essentially hermaphroditic in the structure of its reproductive organs, while the other two are as distinctly monocious or unisexual. A marked difference is also to be noted in the relative size or calibre of the reproductive follicles in the hermaphroditic and in the unisexual species. In *O. edulis* the calibre of the generative tubules appears to be relatively much greater than in *O. virginica* and *O. angulata*, nor are the tubules so densely crowded together as in the latter species. Up to this time this difference appears to me to be so marked that I think it would be possible to distinguish sections of *O. edulis* from those of the other two species by means of this one character. In other respects the history of the development of the reproductive tissues in both species appears to be similar. In all, the sexual tissue arises as a linear interstitial differentiation between the coarse connective-tissue cells of the animal, only that in *O. edulis* the rudimentary network does not form quite so close a meshwork as in the other two forms here

considered. The tubules have a more extensive anastomosis with each other in the unisexual species than in the hermaphroditic. In all the forms fine vessels pass off from the dorsal and ventral somatic arteries, which tend to branch into vessels of a capillary fineness amongst the reproductive follicles. Thus the glandular portions of the reproductive organs are effectively nourished by supplies of blood passing from the great vessels given off by the heart. These are the principal characteristic features of the reproductive follicles in the hermaphroditic and unisexual forms which are noticed upon comparing the two together. The most important differences between the two forms are to be found, however, in the mode in which the generative elements are produced in each type, which we will now consider.

In *O. edulis* the reproductive glands, when well developed, show in many cases a lining of large nearly mature ovules or ovarian eggs at intervals; and insinuated between them large coarsely granular bodies may be observed, in which large irregular nuclear bodies are often imbedded. These nuclear bodies are further distinguished from those of the ovules by their oval or oblong and often irregular form, and by containing a dense mass of granules which absorb safranin in such quantity as to become opaque. This granular *chromatin*, as it would be designated by Flemming, is usually aggregated at the centre of the nuclear or cellular mass, whichever it may be, and is furthermore apt to conform to a certain extent to the external outline of the body which contains it. From these bodies the rounded granular cells appear to arise which fall into the cavity of the tubule or follicle, there to undergo further segmentation, and finally break up into spermatozoa with spherical heads and filiform tails or flagella. Even (in some cases) where no spermatozoa are as yet revealed by the methyl green, these rounded spermogens or spermatoblasts are to be seen free in the centre of the follicles. Usually, however, the spermatoblasts have been crowded towards the external end of the tubule, where they have undergone differentiation into spermatozoa. The spermatozoa are often on this account so crowded together at the outlet of the tubules, passing even into the superficial ducts, that when acted on by the methyl green they are revealed as a dense almost opaque dark bluish-green mass. The ovules, on the other hand, which may be quite nearly mature, remain unstained, except their spherical clear nucleus and nucleolus, which is double, as if formed of two conjoined spherules. If the safranin has been washed out of the nucleus, the one spherule of the nucleolus only is apt to retain the colour. The

peculiar nucleus of the ovules at once distinguishes them from the elements which later break up and become the spermatozoa. Apparently every phase of the spermatogenetic process is under way in the follicles, while more or less nearly mature ovules may be adherent to the walls of the same tubules. In some specimens I find the tubules to contain nothing but ova, with little or no trace of spermatoblasts; in others, again, both classes of products may be present in about the same condition of maturity. In still others little else but spermatozoa are to be found, but, adherent to the walls of the follicles, cells are to be found which have the nucleus so characteristic of the more mature ovules. These, I am inclined to believe, are the representatives of what will later become ova, and not the representatives of spermatoblasts. It is a singular fact that the spermatozoa have a tendency in *O. edulis* to cling together in masses of about a uniform size. Though the spermatic particles which compose these masses are somewhat separated from each other, if compressed together they would evidently form a body about the size of the spermatoblasts from which they were derived. Later they tend to break up and form a more homogeneous granular mass at the outlet of their parent tubule, where the latter joins the outgoing efferent duct. While it is true that some sections of *O. edulis* show little evidence of the presence of any thing else but the product of one sex, it appears to me that there is sufficient evidence of the hermaphrodite character of the generative glands of the species presented by a pretty large series of sections taken from about fifty individuals from different localities along the coasts of Wales, Scotland, England, France, Holland, and Germany. Sometimes a portion only of a section will be hermaphroditic, showing that different parts of the generative glands of the same animals may be of different sexes. The result of this arrangement is that it is scarcely possible for the eggs to escape impregnation by the milt generated alongside of them, and we may, I believe, fairly assume that *Ostrea edulis* is a self-fertilizing hermaphrodite.

The condition of things in the generative tubules of *Ostrea virginica* and *angulata* is very different, as may be gathered from the following account. In the first place I have never found any evidence of hermaphroditism either in the living animal or in sections of the reproductive organs. The mode of pressing out the spawn from the gland and ducts of *O. virginica*, and the physical test used to determine the sex of the products in practical work during the last season, afford the most positive demonstrations of the unisexuality of that species.

Examining sections, however, we never find either in the reproductive follicles of *O. virginica* or of *O. angulata* any evidence of the coexistence of ovules and spermatozoa. In fact the mode of spermatogenesis in the unisexual species is very different from that of the hermaphroditic. As indicated in Brooks's figure of a part of a section of a male oyster, the spermatozoa are peculiarly arranged in the follicle or tubule. Upon applying a high power (500 to 800 diameters) I find that the heads of the spermatozoa show a very marked tendency to be arranged in rows like beads, and not in oblong clusters as in the hermaphroditic species. Moreover the walls of the generative tubules are lined by relatively very much smaller spermatoblasts than those found free in the reproductive follicles of the hermaphrodite form. This spermatogenetic layer is often very marked in the males of the unisexual species, and even at an early stage of the functional activity of the testicular organ presents much the same structure that it does later. The rows of spermatozoa already alluded to also have a tendency to be bent towards the outlet of the tubules, giving rise to a fringe-like appearance on either side of the follicle with a clearer space between the edges of the fringe-like masses of spermatozoa. In fact it is plainly to be seen that the spermatozoa are being budded off from the spermatogenetic layer, and that the appearances just described are a result of that process. It results from this that the structural peculiarities of the testicular tubules are very characteristic, so that once recognized they will never afterwards be confounded with the arrangement observed in the ovary of the female, where, as in the hermaphrodite species, the ova may be seen in different stages of development, though, where the majority of the ovules have attained nearly full development, it may happen that few of the nascent ovules closely adherent to the walls of the follicles are visible.

The distinction between *Ostrea edulis* and the American and Portuguese species is therefore very marked and important. Möbius ('Die Auster und die Austernwirtschaft,' Berlin, 1877, p. 19) says of their species:—"Oysters are hermaphrodites. In the largest number of individuals, in the whole reproductive organ I found only spermatozoa, but no eggs. In seven oysters which carried blue brood in the beard, the sexual gland contained only spermatozoa. Three oysters with younger white embryos in the beard had no spermatozoa in the sexual gland. In the most of the brood-bearing oysters the sexual gland contained neither eggs nor spermatozoa. Of 309 oysters which were taken on the 25th of May from four different banks east of the island of Sylt, and afterward examined

from May 26 to June 1, 18 per cent. were hermaphroditic, and of the remaining 82 per cent. one half were egg-bearing, the other half sperm-bearing. In none were the sexual products completely mature. From these observations I conclude that the eggs and spermatozoa do not develop simultaneously but successively in the sexual gland; that spermatozoa may be developed very soon after the discharge of the ova, and that probably one half of the oysters of one locality during a breeding-period produce only eggs and the other half produce only spermatozoa." To the same effect are the statements of Lacaze-Duthiers; but Davaine seems to have first noticed the peculiar aggregations of spermatozoa in oval masses in *Ostrea edulis*. Brooks thinks "Gerbe's statement, that among the 435 European oysters one year old he found 35 with young, 127 with ripe eggs, and 189 with ripe semen, seems to be sufficient to show the incorrectness of Lacaze-Duthiers's conjecture that the functionally male condition precedes the functionally female condition."

This is about the state of the controversy at present in regard to the breeding-habits of *Ostrea edulis*. The only authority, as far as I am aware, who distinctly takes the ground that eggs of this species are fertilized in the reproductive organs is Horst, who says, "Not only do the embryos pass through their first stages of development within the mantle-cavity of the adult, and impregnation occurs internally instead of externally, but it may also be said that the eggs and spermatozoa come into contact in their passage out of the generative glands." It is barely possible, indeed probable, if my memory serves me rightly, that Davaine has put similar observations upon record. Horst also distinctly asserts that the normal development of the embryos of *Ostrea edulis* cannot take place outside of the parent. M. Berthelot, according to Mr. Brandely, has discovered that the fluids in the mantle-cavity of *O. edulis* contain albumen in a notable proportion, upon which the young are supposed to be nourished. Mr. Brandely has found, by direct experiment, that in the case of *O. angulata* it is possible to artificially impregnate the eggs. His attempts to fertilize the eggs of *O. edulis* with the milt of *O. angulata* and *vice versa* were unsuccessfully repeated at different times for the last two years. I am now also uncertain in regard to the identity of the species of which Lieut. Winslow succeeded in artificially impregnating the eggs at the mouth of the St. Mary's River, in the Bay of Cadiz, Spain, which he says were natives, the variety having existed and flourished in the bay for as far back as could be remembered. I quote his description of the specimens he used in his experi-

ments as follows :—" In appearance they were quite similar to the American species (*Ostrea virginica*), having long shells of from 1 to 3 inches in length, rougher and thicker than is usually the case with the European oyster." This remark raises the question whether the experimenter was not really working with *O. angulata* instead of *O. edulis*. The locality where he got his specimens and where he conducted his experiments also makes it not improbable that he was in reality working with the native unisexual species, *O. angulata*.

To return to the question of the breeding-habits of *Ostrea edulis*, it appears to me that we cannot very well question the authority of Möbius, Lacaze-Duthiers, and Horst, in regard to the bisexual state of the reproductive organs. My investigations also give some countenance to the fact of a preponderance either of eggs or of spermatozoa in different individuals; in fact, in some cases the one or the other seems to be almost exclusively the mature product. But we are not yet in a position to arrive at a conclusion in this matter, because of the scantiness of the observations which have hitherto been made. The hypothesis that the spermatozoa are drawn from without into the generative ducts by the ciliary action of the gills and mantle may be dismissed with the remark that microscopic investigation, to my mind, has effectually disposed of the probability of any such a state of affairs. We may see the spermatozoa in course of development in the same follicle with the ova, which is conclusive proof that the milt has not been derived from without, from the water into which it had been discharged by neighbouring individuals. In truth, we find in some cases the spermatozoa present so deep down in the utmost ramifications of the generative follicles that it is not conceivable that they should have been drawn in from without.

As to the alternate activity of the organs in producing ova and spermatozoa, there is a possibility that such is the case, but, as stated at the outset, there is as yet no conclusive proof of the fact. Certain it is that I have yet to see sections of *O. edulis* in which both ova and spermatozoa are not present in some condition of development at the same time. If the one be not present in a fully developed state, developing traces of it may be discovered; or even a very minute quantity of developed milt or a few developed eggs may be present in some one follicle, while in the others there are perhaps exclusively eggs or exclusively milt in a developed condition. I am aware that this view of the matter is opposed to the current doctrine that nature provides against continuous interbreeding; but when we find the eggs and milt about equally

advanced in development in the same follicle, what is there to prevent self-fertilization; in fact, what else can be the mode of reproduction?

In some of the sections of *O. edulis* examined by me, the ovules already measured $\frac{1}{250}$ of an inch in diameter, showing them to be about twice the size of the ripe eggs of *O. virginica* and *O. angulata*, in both of which the ova are of about the same size when mature. Estimates which I have made, based on the figures of the eggs of *O. edulis* given by M. Davaine, show them to be $\frac{1}{150}$ of an inch in diameter. Estimates based on the figures of Lacaze-Duthiers give $\frac{1}{100}$ of an inch, while Möbius and Horst give the size of the young fry at $\frac{1}{125}$ of an inch in diameter. The spherical heads of the spermatozoa of the three species here discussed measure about the same, or approximately $\frac{1}{3000}$ of an inch in diameter. The clusters of spermatozoa of *O. edulis* measure approximately $\frac{1}{750}$ of an inch in diameter. The spherical unsegmented spermatoblasts which break up into spermatozoa in *O. edulis* measure $\frac{1}{1500}$ of an inch in diameter. The nucleus of the ovarian eggs of *O. edulis* measures not quite $\frac{1}{50}$ of an inch in diameter. The nucleus of the ovarian egg of *O. angulata* measures approximately $\frac{1}{333}$ of an inch in diameter, which is about that of the nucleus of the egg of *O. virginica*. The large spherule of the nucleolus of the egg of *O. edulis* measures $\frac{1}{2750}$ of an inch in diameter; the small spherule, which is stained red by the safranin, measures $\frac{1}{4250}$ of an inch; the long diameter of the conjoined spherules is $\frac{1}{1750}$ of an inch. The long diameter of the nucleolus of the egg of *O. angulata* and *O. virginica* is about $\frac{1}{4000}$ of an inch. A slide in my possession containing some of the brood of *O. edulis* shows that, even after it has acquired both valves of the shell within the beard of the mother oyster, the brood varies greatly in size. I find, for example, that such fry measures from $\frac{1}{100}$ of an inch down to as small as $\frac{1}{150}$. This brood, like that of the American oyster, has not yet acquired any umbonal prominences at the hinge end of the valves. Before this occurs in the American-oyster embryo considerable growth has taken place; but when the shell already covers the body the whole embryo, contrary to what is found in the European species, measures little, if any, more in diameter than the egg, or about $\frac{1}{500}$ of an inch. Later, when the embryo has grown considerably, and when it is on the eve of attaching itself permanently, it measures from $\frac{1}{50}$ down to $\frac{1}{30}$ of an inch in diameter. The mode of fixation of the fry of both species is probably the same; but the mode of incubation (the one in the mother, the other in the open water), we see, is widely differ-

rent, differing as greatly in this respect as do the eggs in size and details of construction, as shown by the measurements which I have given. It must not be forgotten, however, that the material from which I prepared my sections was received from Europe in January and March, when it is to be supposed that the reproductive organs were not yet fully developed, and that consequently the dimensions of the ovarian ova as found by me are rather to be considered as being below than above their true ones when fully developed at the height of the spawning-season.

It is a very remarkable fact that one finds individual specimens of oysters in which the reproductive organs have undergone total atrophy or wasting-away at the completion of the spawning-season. Examining sections through the body-mass of spawn-spent oysters taken from their native waters in August last, I find that the whole of the connective tissue subjacent to the mantle, and between the latter and the liver, especially over the sides of the body-mass, has disappeared, together with all traces of the reproductive organs, including the superficial branches of the efferent ducts. At the first bend of the intestine there is still some of the connective tissue remaining; but even here and in the mantle it has changed its character entirely, and become very spongy and areolar, —instead of solid and composed of large vesicular cells such as are met with when the animal is in a better condition of flesh. In fact, it appears as if this mesenchymal or connective-tissue substance had been used up and converted into reproductive bodies (generative products) in the case of the spawn-spent and extremely emaciated individuals. In sections of individuals in various conditions from that in which the rudimentary network of generative tubules has just appeared in the connective tissue, on up to those in which the reproductive tissues are enormously developed in bulk and proportion to the mass of the remaining structures, there is a perfect gradation from their complete absence to their full development. This would appear to be very strong evidence in support of the theory that the reproductive follicles, or tubules, are developed anew each season directly from the specialization of certain strings or strands of connective-tissue cells.

Many animals manifest a periodic development of the glandular portions of the reproductive organs; but I know of no form in which there is any such presumptive evidence that these organs are annually regenerated and finally altogether aborted as seems to be the case with the oyster. Together with the changes here described, the most remarkable changes in the solidity and consistence of the animal take place. The

shrinkage of a spawn-spent oyster in alcohol or chromic-acid solution is excessive, and will, when complete, reduce the animal to one tenth of its bulk while alive. This shrinkage is due to abstraction of the water with which the loose spongy tissue of the exhausted animal is distended. A so-called "fat" oyster, on the other hand, will suffer no such excessive diminution in bulk when placed in alcohol or other hardening fluid. In consequence of this variable development of the reproductive organs as well as that of the connective tissue of the body-mass, the amount of solid protoplasmic material contained in the same animal at different times under different conditions must vary between wide limits. And inasmuch as the nutritive and reproductive functions of animals are notoriously interdependent, it follows, in consequence of the enormous fertility of the oyster, that a vast amount of stored material in the shape of connective tissue must be annually converted into germs and annually replaced by nutritive processes. Plentitude or dearth of food are also to be considered; but it now becomes a little easier to understand the physiological interdependence of the reproductive function and the so-called fattening process.

To a great extent what has been remarked in the preceding paragraphs of the wasting-away of the reproductive organs in *Ostrea virginica* seems to apply also to *O. edulis* and *O. angulata*. The last species has an extraordinarily thick body-mass, with the stratum of reproductive follicles of remarkable thickness, averaging a much greater development than I have ever seen in any other form. When the contents of this great mass of tubules has been discharged a diminution in the bulk of the body-mass must naturally ensue, probably accompanied by a wasting-away of the connective tissue and tubules, such as apparently occurs in the American species. From what I have seen of the generative tubules of *O. edulis* in sections, they are evidently regenerated much as in *O. virginica*. In a few specimens I find them almost entirely gone, or present only in an extremely rudimentary state.

VI.—*Occurrence of Rhinodon typicus, Smith, on the West Coast of Ceylon.* By A. HALY.

On January 5th a large female shark which I identify as *Rhinodon typicus* was entangled in the nets at a fishing-village called Moratuwa, twelve miles south of Colombo. The native population were greatly excited, and flocked in large

numbers to the beach to see it, fish of this size being very rarely caught on this coast. The following are the principal measurements :—

	ft.	in.
Total length from point of upper jaw to tip of upper caudal lobe	23	9
Girth behind pectoral	13	0
Distance of first dorsal from point of upper jaw	10	0
Anterior edge of ditto	1	10
Base of ditto	1	10
Distance between first and second dorsal	2	8
Anterior edge of ditto	0	11
Base of ditto	0	11
Length of upper caudal lobe	5	0
Length of lower caudal lobe	2	7
Anterior edge of anal	0	9
Base of ditto	0	9
Anterior edge of ventral	1	0
Base of ditto	1	0
Anterior edge of pectorals	3	6
Depth of second gill-opening	2	7
Diameter of spiracle	0	1½
Ditto of eye	0	1½

The width of the mouth when fresh was 3 feet ; but it has shrunk in drying to 1 ft. 11 in. The form of the mouth is lost in the mounted specimen. When fresh the lower jaw was quite straight and flat, nearly, if not quite, on a level with the surface of the abdomen, and considerably in advance of the upper, so that the band of teeth in the lower jaw was quite uncovered. This band averages 1 inch in breadth, and consists of fourteen rows of minute, sharp, recurved teeth, 2 millim. long, all of equal size. The band in the upper jaw is $\frac{3}{4}$ inch broad, and consists of eleven rows of similar teeth. I was in hopes of finding either eggs or embryos, which are occasionally to be obtained from large sharks and skates caught at this season ; but there was no sign of her having approached the shore on account of its being the breeding-season. The stomach contained a quantity of finely divided red matter.

This makes the sixth species, obtained mostly near Colombo, not mentioned in Day's 'Fishes of British India,' and now in the collection of the Colombo Museum. They are :—

Branchiostoma lanceolatum, Pall.

Rhinodon typicus, Smith.

Diodon maculatus, Günth.

Chilinus undulatus, Rüpp.

Xiphochilus robustus, Günth.

Peristethus —? Near Galle, deep water, probably about 50 fathoms.

VII.—*On a Third Collection of Lepidoptera made by Mr. H. E. Hobson in Formosa.* By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

TOWARDS the end of last year I received a small box of Lepidoptera in envelopes from Mr. Hobson accompanied by a letter, of which the following is an extract :—

“Tamsiu,
September 6, 1883.

“DEAR MR. BUTLER,—Having just been transferred from this to the north, I am sending you what moths &c. I have annexed since arrival.

“I had an opportunity of visiting the south cape of the island early in the spring, and obtained the large butterflies down there. The moths are all from this end.”

The collection contained some well-known species previously received, and which Mr. Hobson requested me to forward to the Derby Museum; these species therefore are not included in the present list.

One of the most interesting additions to the fauna in the present consignment is *Hestia clara*, three examples of which (“the large butterflies”) were obtained in the south; an example of *Ornithoptera rhadamanthus* was probably taken at the same time.

The following is a list of the butterflies.

RHOPALOCERA.

1. *Hestia clara*.

Hestia clara, Butler, Trans. Ent. Soc. ser. 3, vol. v. p. 469. n. 6 (1867).

South Cape.

The type of this species was supposed to be from Java.

2. *Parantica aglea*.

Papilio aglea, Cramer, Pap. Exot. iv. pl. 377. E (1782).

S. Formosa.

3. *Ypthima multistriata*, n. sp.

Allied to *Y. nareda* and *Y. corticaria*, intermediate in size between the two. Wings above smoky brown, paler on the disk of the wings, especially in the female, and with blackish

submarginal and marginal stripes: primaries of the female with a large oval bipupillated ocellus towards the apex, the male rarely showing a trace of a similar ocellus, but usually entirely destitute of it: secondaries with a large circular unpupillated ocellus on the first median interspace, and frequently, in the male, one or even two minute subanal ocelli in an oblique line with the large ocellus: primaries of the male with a blackish nebula over the median area. Under surface sordid white, the primaries and base of secondaries more or less suffused with brown, and the entire surface of all the wings densely covered with numerous sharply defined darker brown striæ; marginal and submarginal stripes as above: primaries in both sexes with a well-defined bipupillated black subapical ocellus with pale yellow iris; a dark brown stripe from just beyond the middle of the costa across the disk to the termination of the submarginal stripe: secondaries crossed beyond the middle by an irregularly angulated stripe, sometimes barely traceable, but usually well defined; three well-defined ocelli, one apical and two subanal, the last being smaller than the others and bipupillated. Expanse of wings 37-42 millim.

Seven examples, N. Formosa.

The specimens of this species are for the most part more or less shattered, as though they had been long on the wing.

4. *Calysisme mineus*.

Papilio mineus, Linnæus, Syst. Nat. i. 2, p. 768. n. 126 (1766).

N. Formosa.

5. *Cyaniris puspa*.

Polyommatus puspa, Horsfield, Cat. Lep. E.I. Co. p. 67. n. 3 (1828).

A worn female, N. Formosa.

6. *Nychitona niobe*.

Pontia niobe, Wallace, P. Z. S. 1866, p. 357. n. 6.

N. Formosa.

One example has the apical spot better developed than usual, so that it looks like a pale specimen of *P. xiphia*.

7. *Terias unduligera*.

Terias unduligera, Butler, P. Z. S. 1880, p. 668. n. 22.

N. Formosa.

The external border of the secondaries appears to vary in width, as in the two males now received it is as wide as in

T. hecabe; they may, however, be hybrids between the two species.

8. *Terias hecabe*.

Papilio hecabe, Linnæus, Mus. Lud. Ulr. p. 249 (1764).

N. Formosa.

9. *Ganoris gliciria*.

Papilio gliciria, Cramer, Pap. Exot. ii. pl. 171. E, F (1779).

♀. N. Formosa.

10. *Ornithoptera rhadamanthus*.

Ornithoptera rhadamanthus, Boisduval, Sp. Gén. Lep. i. p. 180. n. 8 (1836).

♀. S. Formosa.

Owing to press of work it has been necessary to defer giving an account of the moths in this collection.

VIII.—*Note on the Detection of Polycystina within the hermetically closed Cavities of certain Nodular Flints.*
By Surgeon-Major WALLICH, M.D.

IN continuation of my previous papers on the "Origin and Mode of Formation of the Cretaceous Flints"*, I beg to announce the discovery by me, last summer, of a number of well-marked *Polycystina* amongst the loose fossilized contents of nodular flints obtained from the Surrey gravel-pits. In common with other observers I have often noticed minute objects in flint sections, which are, in all probability, the remains of these organisms; but in no instance were the appearances revealed by the microscope sufficiently distinct to place their identity beyond question. In the case of the structures now under notice there can be no doubt of the kind; and we are thus furnished with another interesting link in the chain of evidence which goes to prove the general lithological identity of the chalk with recent deep-sea calcareous deposits.

The genera of *Polycystina* met with in the nodular cavities are, for the most part, *Astromma*, *Halimma* (both dis-

* Quart. Journ. Geol. Soc. for Feb. 1880, and Ann. & Mag. Nat. Hist. for Feb., March, and July 1881.

coidal and spherical), and *Podocyrtis*. A few specimens of well-marked fossilized Dictyochidæ also occur. Both the Polycystina and the Dictyochidæ, as well as the mass of the loose granular material associated with them in the same flint-cavities, are more or less metamorphosed by a slight admixture of peroxide of iron and calcite, the former substance having imparted to the entire structures a bright reddish hue.

Through the courtesy of Prof. T. G. Bonney, F.R.S., I have been enabled to examine a slide of "diaspro" containing Polycystina. These, however, exhibit somewhat less of the characteristic structure of the organisms, owing, no doubt, to their having become fossilized under less favourable conditions than those which existed in the hermetically closed flint-cavities. In both cases the polariscope shows the silica to have been partially replaced by calcite.

I have likewise found in material obtained from hermetically closed flint-cavities, by far the most perfectly preserved Foraminifera I have ever seen, the shell-structure and chambers, with every minutest detail of tubular structure, having been converted into chalcedony—the whole mass by reflected light presenting a beautifully whitish-blue opalescent appearance, whilst by transmitted light it exhibits a rich transparent burnt-sienna colour and the well-known fibrous character of chalcedony wherever that substance is most massive, as, for instance, within the chambers. The Foraminifera represented belong chiefly to the genera *Rotalia*, *Globigerina*, and *Textularia*. I may add that, as regards perfection in every minutest detail of shell-structure, these specimens greatly surpass in beauty those metamorphosed into *glauconite*, beautiful as they also undoubtedly are.

IX.—*Notes on the Structure, Postembryonic Development, and Systematic Position of Scolopendrella.* By J. WOOD-MASON, Deputy Superintendent, Indian Museum, Calcutta.

THIS interesting and remarkable type of Tracheate Arthropoda was first made known to science in 1839*, in which year the distinguished zoologist Prof. P. Gervais brought to the notice of the Academy of Sciences at Paris some specimens of a small and fragile Myriopod which had been discovered in the vicinity of the French capital; and founded

* 'Comptes Rendus,' tome ix. p. 532 (1839).

upon them the genus *Scolopendrella*. This preliminary notice was followed in 1844* by a description with figures of the species under the name of *S. notacantha*, which description and figures were in 1847 † repeated in the 'Suites à Buffon.'

A second species was not long afterwards* described and figured, from specimens obtained near London, by our own countryman Newport ‡, who at first thought the genus allied to the Chilopodous *Geophilus*, but eventually placed it in a family by itself between *Lithobius* and *Scolopendra*, notwithstanding that the fourth somite and its appendages are not developed into the basilar plate and poison-claws so characteristic of Chilopoda.

In 1851 a memoir §, which is far the most complete of any that have as yet appeared, was published by Menge on Newport's species *S. immaculata*. This author, who discovered the silk-glands that lie in the last two somites and open at the ends of the caudal appendages, as well as the tracheæ (which he did not, however, correctly interpret), and several other structural features of importance, regarded the genus *Scolopendrella* as "the type of a genus or family intermediate between the hexapod Lepismidæ and the Scolopendridæ;" but he refrained from making a new name.

Lubbock ||, Huxley ¶, and others have briefly referred to the genus.

I myself in 1876** recorded its occurrence in Bengal, and in 1879 †† published a few observations upon it and figured one of the legs.

In 1880 †† Mr. J. A. Ryder recognized in it "the last survival of the form from which insects may be supposed to have descended," and proposed for its reception "the new ordinal group Symphyla, in reference to the singular combination of Myriapodous, Insectean, and Thysanurous characters which it presents;" and in 1881 the same writer monographed the

* Ann. d. Sc. nat. Zool. tom. ii. 1844, p. 70, pl. v. figs. 15-17.

† Walckenaer et Gervais, Ins. Aptères, t. iv. pp. 301-303 (1847).

‡ Trans. Linn. Soc. Lond. vol. xix. pp. 373, 374, pl. xl. figs. 4, 4 a, b, c; and Cat. Myr. Brit. Mus.

§ "Myriapoden d. Umgegend v. Dantzig," in Neueste Schr. d. naturforsch. Gesellsch. in Danzig, iv. 4tes Heft.

|| 'Monograph of Collembola and Thysanura.'

¶ 'Anatomy of Invertebrate Animals.'

** Proc. Asiat. Soc. Bengal, August 1876.

†† "Morphological Notes bearing on the Origin of Insects," in Trans. Ent. Soc. Lond. 1879, p. 153, fig. 2, B.

‡‡ Amer. Nat. May 1880. The number of this publication for September of the same year contains a note on Ryder's communication, with some figures and suggestive remarks on *S. immaculata*.

group*, describing a new species, and giving a useful summary of Menge's important paper.

In 1881† there appeared a paper by Dr. Jos. Muhr which is said to contain a valuable description of the mouth-parts of a new species closely allied to *S. notacantha*, but which I have not yet seen.

Finally, in the present year Dr. S. H. Scudder, of Cambridge, Mass., U. S. A., described a new species under the name of *S. latipes*.

I have arrived at the conclusion that *Scolopendrella* is a Myriopod which, while resembling the Chilopoda in the form of the body, is more nearly related to the Chilognatha; but whether it should be classed as a suborder of the latter or in an order by itself we shall be better able to say when we shall have learnt more about its anatomy and development than we at present know. And I regard it as the descendant of a group of Myriopods from which the Campodeæ, Thysanura, and Collembola may have sprung, looking upon the three latter groups as the living representatives of the extinct stock or stocks from which the various orders of insects have originated,—the jointed (Myriopodous) mandibles and the presence of two pairs of appendages (the one a pair of walking-legs and the other a pair of styliform rudiments) on each of the two hinder thoracic somites, and of two pairs of rudimentary feet on each of two of the abdominal somites, in *Machilis* seeming to me explicable only on the hypothesis that this form is descended from an animal allied to the Chilognatha, and the somites of whose body were provided with two sterna, each furnished with a pair of appendages of the value of legs; and the resemblances of the true insects through *Blatta* to the Entomopsida (Campodeæ, Thysanura, and Collembola), on the hypothesis that the two have a common ancestry.

Seeing that there occur in combination in *Scolopendrella* two of the most remarkable features of *Peripatus*, namely two-clawed feet and segmental openings, its ancestry may be inferred to have lived and flourished before the present types of Myriopoda were evolved; and it may therefore throw much light on the origin of Myriopods also: it may, for example, afford an explanation of both the modes of addition of fresh segments—that which “takes place by the way of intercalation at each moult in the intervals between each pair of older segments,” and that by their interposition between the penul-

* Proc. Acad. Nat. Sci. Phil. 1881, pp. 79–86.

† Zool. Anz. iv. 1881, pp. 59–61, figs. 1, 2, and 4.

timate and antepenultimate somites—which obtain in Chilopoda, and of the nature of the double somites in Chilognatha.

The Head.—This is not so depressed as it is represented to be in the published figures, but is anteriorly deflexed, with the antennæ articulated to the forehead, much as in the Chilognathous Myriopoda. Its anterior margin is divided by a median notch into two rounded, thickened, and highly indurated lobes, each armed at the extremity with three sharp spiniform processes supported by buttress-like thickenings and directed with their fellows of the opposite side towards the middle line, thus recalling the sharp and toothed rostrum of Chilognatha.

On the upper surface of the head, behind the insertion of the antennæ, and in the same transverse line as the mandibular articulations, lie a pair of smooth and slightly convex areas with an exceedingly sharply defined and doubly contoured oval outline; they appear to be cake-shaped involutions of the integument; and their walls are covered with a minute punctuation, which may possibly be the optical expression of the ends of fine canals. If a spirit-specimen of the animal be placed whole in a solution of hæmatoxylin for a few hours, these organs become filled, or their contents deeply coloured, by the reagent; so that they must freely communicate with the exterior. Whether they are glands, or stigmata, or eyes, can only be decided by means of sections; it would be worth while to compare them with the paired organs externally visible in the corresponding part of the head in *Glomeris* as conspicuous horseshoe-shaped impressions. Between these structures and the insertion of the antennæ I have not yet succeeded in making out the "round black eyes" which have been described by Menge; and it is possible that the two may be the same.

Previous observers have all recognized two pairs of jaws in addition to the mandibles, namely a pair of first maxillæ and a pair of second maxillæ, equivalent to the so-called labium of insects, but no other cephalic appendages; and they all appear to me to have misdescribed those that they have recognized.

I, on the contrary, see in the supposed two pairs of gnathites that succeed the mandibles but the coalesced parts of a single pair, resembling in all essential particulars the four-lobed plate that follows the mandibles and functions as a lower lip in the Chilognatha; and I have no doubt that the first pair of legs is the third pair of postoral appendages answering to the labium of insects.

First Pair of Postoral Appendages.—In specimens mounted

in spirits, with the dorsal surface upwards the mandibles are visible beyond the sides of the head, between the oval sacs above described and the insertion of the antennæ. They are therefore attached very far forwards; and their strong articulation is rendered very conspicuous by the amber-like colour of the cuticle, both of their posterior extremity and of the part of the head into which this fits—amber-like coloration indicating the great firmness of the chitinization that has taken place. They are divided by a very distinct joint, visible just in front of the insertion of the antennæ, into two segments: the first of these is a slightly curved prism attached to the head by its dorsal margin, and to the outer lobe of the four-lobed plate by its ventral margin, its inner side being consequently open, so as to give passage to the flexor muscles, which are inserted into the inner face of its outer wall; the second, a triangular plate, is armed on its inner side with two distinct series of teeth distinctly separated from one another by a rounded notch, the posterior series consisting of five small equal pale and blunt tubercular ones, and the anterior of four dark brown and highly indurated sharp teeth, of which the anterior and outer is slightly the largest, and lies in a different plane from the rest; from the bottom of the notch between the two series of teeth a faint groove encircles the joint, subdividing it into two, corresponding respectively to the first (which in *Glomeris* is developed on the inner side into an antero-posteriorly elongated molar process) and second or apical (which is bifurcate*) free joints in Chilognatha generally. The mandibles can be readily disarticulated from the head, as also can their two principal joints from one another. They are, in short, built exactly upon the plan of those of the Chilognatha, being divided into three distinct joints, and therefore not consisting, as has been stated, of a single piece only.

Second Pair of Postoral Appendages.—These are made up of seven or eight distinct sclerites, all united together by membrane, namely:—four lateral, of which two are long and

* The apical joint in all Chilognatha consists of two parts attached to a common base (the first free joint), but lying in different planes and applied to each other, much as are the "galea" and "lacinia" of the first maxillæ in such an insect as the common cockroach—an arrangement strongly suggestive of its being, like the jaws of *Peripatus*, a modified pair of claws. The objection to this is that all living Myriopods except *Scolopendrella* have the legs terminated by a single claw; and it would be fatal were it not that the legs of the Protracheata are biunguiculate. The uniunguiculate condition of the legs in most Myriopods, in the larvæ of many insects, and in all the Collembola is probably adaptive.

anterior or apical, and two are short and posterior or basal; two median; and one or two basal. The two median sclerites are much broader than the long laterals; and they form together a broadly spatulate figure, which extends quite up to the toothed and lobed anterior margin of the head in front, and behind is divided into two divergent horns embracing the sides of the triangular basal sclerite. The long or apical lateral sclerites are attached not only to the medians and by the basal moiety of their outer margins to the ventral margin of the basal joint of the mandibles, but also by the intermeditation of the short laterals to the basal part of the basal sclerite, which may be divided transversely into two parts; and they taper from their base to their apex, which reaches only to the end of the first mandibular joint and carries two large movably articulate appendages. These ordinarily lie with their apices all directed towards one another in the middle line, concealed beneath the rounded end of the conjoined median lobes; but when pressure is put upon the covering-glass they diverge and project straight forward for some distance beyond the front of the head*. They both lie in the same plane; and the outer (which is a highly indurated, slender, straight, and tapering organ, hooked at the extremity and provided internally with a minute anteapical spiniform process) fits the inner (which is a soft finger-shaped body with a brush of apparently implanted bristles on its inner extremity) as the "galea" does the "lacinia" in the first maxillæ of the cockroach—with which parts of the insectan maxillæ they can have nothing whatever to do, being plainly homologous with the two short and similarly convergent appendages that are present at the end of each outer lobe of the same pair of jaws in all Chilognatha, and being probably, like these and like the tips of the mandibles, modified pairs of claws inherited from the common Protracheate ancestor.

Third Pair of Postoral Appendages.—Of the fifteen dorsal sclerites which in adults follow the head, the first is little more than a mere short and transverse fold of skin with scarcely a trace of the conspicuous imbricating process given off from the posterior margin of all its successors; it is the tergum of the somite that bears the first pair of legs. These differ from those of the remaining eleven pairs in being conspicuously smaller and slenderer, with their last joint elongated, and their last but one shortened and apparently confounded with the third, in being more approximated at

* The fore margin of the median lobe also becomes protruded so as to display the six conical spines with which it is furnished.

their bases (where they are attached to two small oval sclerites nearly touching one another in the middle line), but above all in the important circumstance that they are never brought to the ground, but, on the contrary, are turned forwards under the head so as to be quite invisible from above in the living animal; commonly, indeed, they are folded akimbo across the under surface of the back of the head; they without doubt belong to the head, and they must, as they follow the four-lobed plate, be held to correspond to the similarly pediform and attached appendages of Chilognatha, and, as a consequence, to the labium of the Insecta.

The Somites of the Body and their Appendages.—The body of this little animal is extremely soft and fragile and extensible, and tapers visibly from the fourth leg-bearing somite towards the head, which is but little broader than the tergum of its hindermost somite. It is little, if at all, broader than high; and the soft membrane intervening on its sides between the leg-bases and the projecting lateral margins of the tergites is complexly puckered and folded in a manner reminding one of the Chilopoda. It is defended above by thirteen (exclusive of the caudal somite, which would appear to be double) imbricated plates or terga, whose hinder margin is divided by a pronounced emargination into two rounded lobes. In this series of terga no such regular alternation of longs and shorts as obtains in many Chilopoda is to be observed, nor equality, nor regular decrement or increment, but, on the contrary, a marked irregularity in length—an irregularity, however, which is identically the same in all the specimens hitherto examined.

On turning to the ventral surface, a consecutive series of eleven precisely similar regions, to each of which two distinct pairs of appendages are movably articulated, can readily be made out, or two less than the number of the terga opposed to them; consequently two of these must be without either appendages or sterna, or two of the somites must be considered to be provided with double terga. In each of these sternal regions two pairs of sclerites are discernible:—a posterior pair of nearly circular and smaller ones, which, without doubt, corresponds to the small and similarly shaped ones that carry the hindermost pair of cephalic appendages, and external to which a pair of stout five-jointed and biunguiculate legs are attached; and an anterior pair of elongated and larger sclerites, near to the postero-lateral margins of which, and between which and the legs, are articulated a pair of short setose styles.

This arrangement of the parts at once suggested the suspicion that each of the regions was made up of two sterna, each marked by a pair of appendages, the anterior and inner of which had become reduced to styliiform rudiments—a sus-

picion the correctness of which has been verified by the study of several stages in the postembryonic development of the animal. So that eleven pairs of rudimentary legs and eleven pairs of functional ones, or twenty-two in all, marking as many separate somites, are to be made out in this animal between the head and the tail.

The presence of the two apodous terga and of the eleven pairs of rudimentary feet seems intelligible only on the supposition that *Scolopendrella* has been evolved from a form with twenty-two distinct and complete leg-bearing somites, by the reduction to rudiments of the legs (accompanied by the abortion of the metamerically arranged organs, such as stigmata and excretory pouches of the somites), and the suppression of all but two of the terga of alternate somites.

The terminal tergum, which is longer than broad, truncated at both ends, and slightly arched at the sides, probably consists of two connate terga. It is converted posteriorly, apparently by the inbending of its sides, into a complete ring divided by vertical partitions into three compartments, to the two outer of which the perforated caudal appendages are attached, and into the median and dorsally emarginate one of which it is probable that the anus opens.

Between the complete ring formed by the posterior end of the last tergum and the last of the series of double sterna are interposed two plates, which I take to be the sterna of the last somite; of these the posterior, which extends beyond the extremity of the body, is soft and deeply cleft in the middle line; while the anterior, which is semicircular, and covers like an operculum all but the free margin of the posterior, is firmly chitinized and has its straight hinder margin entire. The postero-lateral margins of the latter are each produced into a short cylindrical process encircled with setæ and hollowed out at its extremity into a cup-like concavity, from a tubercle in the bottom of which springs an excessively long and fine and gradually tapering simple seta; this pair of setigerous processes, which have much more the appearance of rudimentary legs than of mere processes, especially in the larvæ, are probably sensory organs of some kind; whilst the aperture of the genital organs (which, according to Menge, to whom we are indebted for all our knowledge of the internal anatomy, open at the hinder end of the body) is probably situated in the former rather than in the anterior part of the body, where I have hitherto failed to make out any other openings but those I have described below.

Organs of Respiration.—These consist of eleven tracheal arches, opening by as many pairs of minute pores, situate on

the anterior faces of the leg-bases. If a moribund specimen be placed on its side under the microscope, a row of minute specks as bright as globules of quicksilver is seen, and remains visible until the contractions of the tissues consequent on drying have driven all the air from the tracheæ; and in specimens killed and discoloured by osmic acid, the stigmata, with the tracheæ running from them, are to be seen with the greatest distinctness, the latter being marked out by silvery streaks due to the presence of air. The tracheal tubes are all devoid from their very origin of the spiral thickening of their walls, so characteristic of the tracheæ of insects. Each of the stigmata leads into a tube which passes inwards, backwards, and upwards, slightly increasing in calibre as it goes, and meets its fellow of the opposite side in the middle line so as to form an arch; at the point where the tubes of opposite sides meet one another there is a slight blurriness or break in the continuity of the arch; and there is an irregularity in the height of the arches, to a certain extent corresponding to the irregularity in the length of the terga already noticed. No tufts of tubes appear to be given off from the arches; and I have not as yet made out in the body any other tracheæ besides these metamerically arranged ones. In the head, however, there are certainly tracheæ present; but I have not yet studied them sufficiently to be able to speak confidently about their arrangement and distribution.

The huge "crateriform openings," considered by Ryder to be the stigmata, have nothing whatever to do with the respiratory apparatus, the openings of which are excessively minute.

The respiratory apparatus of *Scolopendrella* consists, then, as far as it has yet been made out, of a series of eleven backwardly directed arches, opening by as many pairs of minute stigmata on the anterior faces of the leg-bases. If, in addition to the posterior arch, each pair of stigmata gave off an anterior arch, and every anterior were anastomosed in the middle line to a posterior arch, we should have an arrangement precisely similar to that which we meet with in the segmentally arranged portion of the tracheal system in such a Chilopod as *Geophilus*, in which a similar blurriness is to be seen at the points of anastomosis of the anterior and posterior arches.

? *Excretory Apparatus*.—Besides the stigmata, there is on every pedigerous somite, except certainly the first, and possibly also the second, eleventh, and twelfth, a pair of huge two-lipped apertures surrounded by a low circular wall, the summit of which is defended by a circlet of movable spines. They are in the round sclerites to which the functional legs

appear to be attached; and they therefore are posterior to the rudimentary legs. If a specimen be placed for a short time whole in a solution of hæmatoxylin, the everted mouths or the coagulated excreta collected upon these become deeply coloured by the reagent, so that the ventral surface of the animal is marked conspicuously with a double row of large round black-violet spots. An accident unfortunately happened to the specimen thus treated before I had had an opportunity of actually counting and noting down the number of openings that had been coloured; and I have been obliged to suggest that the round sclerites of the second, eleventh, and twelfth pairs of legs may be imperforate, though I fully believe that they are perforate like the rest. These openings possibly lead into glands which are homologous with the nephridia of *Peripatus* and with the glandular pouches of *Machilis* and *Campodea*; their exact morphological value is only to be determined by means of sections, which I hope shortly to have an opportunity of making. They are no doubt the apertures mistaken by Ryder for the stigmata, and which are stated by Scudder to be big enough to admit the tips of the legs.

Postembryonic Development.—Menge, according to Ryder's synopsis of his paper, met with a young animal provided with only eleven pairs of legs, and concluded that it was the first pair which was wanting; I, on the contrary, have never failed to recognize the first pair by its characters at any stage, and I am confident that it is one of those in possession of which the animal leaves the egg. Newport and Ryder both noticed "specimens of different ages with nine, ten, eleven, and twelve pairs of legs." I can confirm their observations, which prove that a pair of legs is added at each moult; and I have succeeded in making out the position of the germinal region.

In larvæ provided, in addition to the three-jointed first pair of legs which properly belong to the head, with seven pairs of rudimentary and seven pairs of functional legs, nine terga (exclusive of those which respectively carry the pediform third cephalic and the caudal appendages) are present, or two more than the number of double pairs of feet. It is difficult, owing to the manner in which the terga seem to have been thrown out of correspondence with their double sterna, to determine with certainty which these apparently apodous terga are; but they appear to me to be the fourth and seventh (the fifth and eighth if the third gnathites are reckoned in with the ambulatory legs) and the dorsal arcs of the somites to which the fifth and sixth pairs of rudimentary feet belong. A certain knowledge of this, as of many other points in the structure of

this interesting form, is only to be reached by carefully tracing the different stages of its development, step by step, from the egg. In larvæ of this stage the membranous interval between the bases of the last-formed (seventh pair) legs and the base of the setigerous penultimate sternum is found to be divided into two segments by a transverse groove; the anterior of these segments is by far the longer, and the posterior is very short: to the extreme outer ends of the posterior margin of the latter are attached a pair of conical processes constricted at their base; they are the buds of the future eighth pair of functional legs, and they lie wedged between the setigerous processes and the caudal appendages, below (but in the same vertical line with) which they are attached. From the posterior margin of the longer and anterior of these two fresh segments, but rather nearer to the middle line, two similar, but much shorter, conical processes arise and lie appressed to the surface of the setigerous sternum; these are the buds of the future eighth pair of rudimentary legs.

The addition of fresh somites therefore takes place in this animal by the intercalation of two at each moult between the antepenultimate and penultimate sterna, as in the Chilognatha, and as also in some of the Chilopoda, as far as some, at all events, of the somites are concerned, until the full number is attained.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

April 25, 1883.—J. W. Hulke, Esq., F.R.S.,
President, in the Chair.

The following communication was read:—

“On the Skull of *Megalosaurus*.” By Prof. R. Owen, C.B., F.R.S., F.G.S.

The specimens described in this communication were obtained by Edward Clemenishaw, Esq., from the freestone of the Inferior Oolite near Sherborne (Dorset) from some blocks which had been quarried for building-purposes. These were sent by him to the British Museum, where the remains have been developed. One block includes a great proportion of the right side of the facial part of the skull, the missing parts being the fore end of the premaxillary, the suborbital end of the maxillary, and the upper hinder pointed

termination of the same bone. Ten teeth are preserved in the maxillary bone. Another block contains the outer side of the right mandibular ramus, with teeth, and with some other fragments. In a third block is the anterior part of the left mandibular ramus, with portions of the teeth. These remains were described in detail; and in conclusion the author discussed the bearing of these and other Megalosaurian remains upon our knowledge of the structure of that animal and its affinity to existing Reptilia, and criticised some of the evidence on which the relationship of the Dinosauria to birds is inferred—a relationship which he had suggested in 1841, but upon grounds which appeared to him to be more satisfactory.

May 9, 1883.—J. W. Hulke, Esq., F.R.S.,
President, in the Chair.

The following communication was read:—

“Fossil Chilostomatous Bryozoa from Muddy Creek, Victoria.”
By A. W. Waters, Esq., F.G.S.

In this paper the author described a collection of fossil Bryozoa, collected and sent over by Mr. J. Bracebridge Wilson, of Geelong. The collection is from Muddy Creek, Bird Rock, and Waurin Ponds, Victoria, and is of the so-called “Miocene” age. There are 64 species, of which 28 are known living; and 18 of these are now found fossil for the first time; but of the rest a large number have previously been found and described from Curdies Creek, Mount Gambier, and Bairnsdale. The author considered that 28 out of this number being known living is a large proportion, seeing that although our knowledge of the Australian recent fauna has been much increased during the last few years, it yet is very imperfect.

The collection furnished 13 species of *Catenicella*, of which 5 at least are known living; and the author indicated the great importance of a thorough study of the living species of that genus. A notch in the aperture simulating a sinus seems sometimes to be replaced by a suboral pore; and a plate on the front of the cell requires further investigation.

Three species are believed to be identical with fossils from the European chalk.

June 6, 1883.—J. W. Hulke, Esq., F.R.S.,
President, in the Chair.

The following communication was read:—

“Notes on a Collection of Fossils and Rock-specimens from West Australia, north of the Gascoyne River.” By W. H. Hudleston, Esq., M.A., F.G.S.

This collection was forwarded to England by Mr. Forrest, who has been engaged for some time past in surveying the northern portion of the colony, and was accompanied by a map indicating the positions

whence the specimens were obtained. The author drew attention to a paper by Mr. Gregory, which appeared in the Quarterly Journal, many years ago, giving a brief description of the country as far as the Gascoyne river in lat. 25° S., together with some diagrammatic sections, which show a belt of sedimentary rocks between the sea and the crystalline plateau forming the interior of the country. This belt of sedimentary rocks widens materially towards the north, being about 90 miles across on the parallel of the Gascoyne river. Amongst the rock-specimens in the Forrest collection are crystalline schists, &c., in which white mica and quartz are the most prominent minerals; and it is evidently from the degradation of masses of this class that the arenaceous rocks containing the fossils were derived. No limestone has been sent; but where the grits are largely charged with fragments of Encrinites, Polyzoa, &c. there is a proportionate increase of calcareous matter. No specimens of coal or of recognizable plants were forwarded.

The fossils chiefly occur in "Fossil range," which runs nearly N.N.W. for over 100 miles; they present a thoroughly Carboniferous (marine) facies, several of the species being identical with or closely allied to well-known Carboniferous Limestone forms. Out of more than 20 species there is only one (a *Pachypora*, allied to *P. cervicornis*) which could be regarded as Devonian. Corals, crinoidal stems, Polyzoa, Brachiopoda, and two large species of *Aviculopecten* make up the list. In the Appendix some of these were described. The corals are chiefly represented by *Amplexus* and *Stenopora*; whilst amongst the Polyzoa are two species of the very curious American genus *Evactinopora*, only known hitherto from the Lower Carboniferous rocks of Illinois. The ubiquitous *Fenestella plebeia* is extremely abundant.

BIBLIOGRAPHICAL NOTICE.

The Young Collector's Handbook of Shells. By B. B. WOODWARD, F.G.S. &c. Small 8vo. London: W. Swan Sonnenschein and Co.

It is not often that we feel called upon to notice a penny book; but the little treatise of which we have given the title above strikes us as so good a work of its kind as to deserve a few words of welcome. Mr. Woodward, as will be seen from the title of his little book, has set before him a very modest purpose; but he has stuck to it in the most praiseworthy manner, and in consequence has succeeded in producing what cannot but prove a most useful manual for beginners in shell-collecting. He tells his readers how to make a cheap cabinet for the reception of their collections, then how to collect the shells to put into it, how to prepare and mount them when obtained, and, lastly, how to classify and arrange their

prizes. The classificatory portion is necessarily a mere sketch; but it is clear, and illustrated with a considerable number of woodcuts, and Mr. Woodward has appended to it a useful table of the principal genera of shells, with indications of their respective number of species and their geographical distribution. A list of a few works of reference (which might have been enlarged with advantage) occupies the last page of the pamphlet, which ought to find a wide acceptance among young collectors.

MISCELLANEOUS.

The "Crag Mollusca."

To the Editors of the 'Annals and Magazine of Natural History.'

GENTLEMEN,—A shell abundant in the Red Crag of Suffolk and Essex was figured by Sowerby, in 'Mineral Conchology' for 1823 (tab. 411. fig. 2), as *Murex alveolatus*, and a variety of it (tab. 414. fig. 1) as *Buccinum tetragonum*. Both, together with a series of varieties connecting them, were figured by my father in the 'Crag Mollusca,' issued by the Palæontographical Society for 1847, under the name of *Purpura tetragona*, by which the shell has now been long known. It has been generally regarded, by foreign and English authors alike, as not living; but in the list to Prof. Prestwich's paper on the Red Crag (Quart. Journ. Geol. Soc. vol. xxvii. p. 490) it is called a variety of *Purpura lapillus*, on the authority, I believe, of Dr. J. Gwyn Jeffreys.

I have found in profusion, in the recent state, on Felixstow beach, a shell undistinguishable from the most abundant variety of *P. tetragona*. It is certainly not any variety of *P. lapillus*, but appears to be a smooth variety of the common British shell *Murex erinaceus*, in which opinion, as well as in that of its identity with the Crag *Purpura tetragona*, Mr. Robert Bell, who has an intimate acquaintance with the Crag Mollusca, concurs.

This variety of *Murex erinaceus* was not known to my father, and therefore was not recognized by him; but having once seen a specimen of the common form of that species in a collection from the Fluvio-marine Crag of Bramerton, he introduced it, but without any figure, at p. 39 of his original work, as a Crag species; and the specimen having been lost, he, in the first supplement to that work (tab. ii. fig. 11), gave the representation of a recent specimen of this form, in order that *Murex erinaceus* might appear as a Crag mollusk.

Under the guise of *Purpura tetragona*, however, it appears to me to have been an abundant shell both of the oldest (*i. e.* Walton) and medial (*i. e.* Sutton) parts of the Red Crag (and not particularly rare in the Crag jaune and Crag gris of Antwerp, according to Nyst); but in the Fluvio-marine part of this crag, from which it was that

the solitary specimen of the common form of *Murex erinaceus* my father recognized came, *Purpura tetragona* does not seem to have occurred.

I may add that these shells, so abundant on Felixstow beach, are not specimens fallen from the Crag-cliff there, washed clean by the sea, but genuine recent shells.

I am, &c.,

SEARLES V. WOOD.

Martlesham, near Woodbridge,

June 16, 1883.

Mediterranean Mollusca.

In consequence of a suggestion made to me by the Rev. R. Boog Watson, that *Brugnonia pulchella* ('Annals,' 1883, xi. p. 399) may be an embryonic form, I have re-examined my specimens and compared them with the young of various Gastropods. It is possible that the species which I described may be the fry of *Cassis sulcosu*, although I cannot satisfactorily determine this for want of young and fresh specimens of the latter species. If this surmise be confirmed by further comparison, *Brugnonia* must be consigned to the limbo of spurious genera, along with *Sinusigera* of D'Orbigny, *Maogullivrayia* of Forbes, and several genera of O. G. Costa.

J. GWYN JEFFREYS.

18th June, 1883.

Further Observations on the Dimorphism of the Foraminifera.

By MM. MUNIER-CHALMAS and SCHLUMBERGER.

In a former communication on the dimorphism of the Foraminifera we have indicated two existing types of *Biloculinae*; we will now show that the extinct species likewise participate in the two series of modifications that we have already noted in the existing species.

Triloculina trigonula, d'Orb.—The form A possesses a very large central chamber ($20\frac{1}{2}\mu$) surrounded by three series of cells, the planes of symmetry of which form with each other angles of one third of a circumference. It will be remarked that the first serial chamber is compressed and corresponds to the canal of the *Biloculinae*. The involment of the chambers from the first to the last remains the same, and follows three directions, passing through the planes of symmetry just mentioned. In this species the individuals of the form A often attain large dimensions.

Triloculina trigonula, d'Orb.—The form B presents one of the smallest central chambers that we have met with; it is only 18μ . Around it are grouped five chambers, which reproduce the arrangement of the *Quinqueloculinae*. This involment does not continue; for, starting from the sixth, which becomes very embracing, the following chambers suddenly take on the Triloculine arrangement.

Pentellina saxorum (d'Orb.).—Middle Eocene, Parnes. This

species must be regarded as the most perfect geometrical type of inrolment in five directions. In the *Pentellinae*, as in the *Quinqueloculinae*, it is observed that the forms A and B are less dissimilar in appearance than in the other genera. Nevertheless these two forms are distinguished at once by the difference of size that occurs in their first chambers. Moreover, around the central chamber of the form B we recognize the presence of some small chambers; but starting from this point the succeeding chambers acquire the Quinqueloculine arrangement so characteristic and so constant in the form A.

Fabularia discolithes, DeFr.—The individuals of the form A are always exceedingly small; the largest have as the maximum not more than seven embracing chambers arranged alternately on each side of the central chamber, which measures $270\ \mu$. The first serial chamber, which represents the canal of the *Biloculinae*, remains simple, while the succeeding ones are divided by longitudinal partitions into narrow more or less circular chambers which communicate with each other by lateral canals. The inrolment, like that of the *Biloculinae*, takes place in accordance with a single plane of symmetry.

Fabularia discolithes, DeFr.—A transverse section of the form B shows that the chambers present three principal modifications in their arrangement:—

1. Around the central chamber, which measures $21\ \mu$, there are grouped five simple chambers; then the nine succeeding ones are arranged more or less irregularly in accordance with their directions. The last two are divided by a thick longitudinal partition, which cuts them into two.

2. From this point the new chambers are regularly opposite to each other; the first six or seven of this series present numerous longitudinal canals arranged in a single series.

3. Lastly, in the third phase the last chambers, to the number of twenty or twenty-two, present a series of more or less irregular supplementary canals towards their inner part.

From this very brief investigation it appears that all the species of *Miliolites* that we have studied are dimorphous. One may easily recognize this dimorphism by comparing numerous sections; the form B will always be distinguished by a much smaller central chamber surrounded by a greater number of chambers than in the corresponding form A.

In the present state of our knowledge it is difficult to pronounce a definite opinion upon the cause of this dimorphism; nevertheless it seems to us that there are only two possible hypotheses.

In the first place it may be supposed that each species is represented by two forms distinct from their origin. But hitherto we have been unable to discover in any of the numerous species that we have studied very young individuals of the form B.

The second hypothesis consists in assuming that the dimorphism is the result of a final evolution. Every individual would then pass

through two successive phases: the first would correspond to the form A; but, in consequence of the resorption of the large central chamber, the animal would construct a series of new chambers corresponding to the form B.

In all the species examined exact measurements have shown us that, supposing the central chamber to be absorbed, the space set free between the first serial chambers of the form A is large enough to allow the modified chambers of the form B to be developed.

It now remains for us, before pronouncing in favour of one of these two hypotheses, to trace a living species through all the phases of its evolution.—*Comptes Rendus*, May 28, 1883, p. 1598.

On Radial and Bilateral Symmetry in Animals. By H. W. CONN.

The relation of radial to bilateral symmetry among animals is a question in regard to which there has been considerable discussion. It is, however, today pretty generally acknowledged that the type of radial symmetry must have preceded that of bilateral symmetry. Two important views are current as to the origin of a bilateral form of symmetry, such as is presented by the group Vermes, from a radial symmetry, such as we find in the Coelenterata. The simplest view, of which Ray Lankester is an exponent, is as follows:—

Starting with a radially symmetrical larva, this view supposes that the two forms of symmetry arose with reference to the stationary or locomotive life of the animal. On the one hand, the stationary animal retains its primitive radial symmetry and grows into a radiate adult. On the other hand, the locomotive larva is modified by its free life. Its growth, in order to give greater freedom of motion, results in an elongation of the body in a direction parallel with its axis. Such a long cylindrical body would of necessity soon develop swimming-organs; and these swimming-organs, in order to give greater steadiness of motion and prevent an inconvenient revolution of the body, would appear in such a position as to give the animal an upper and an under surface, and consequently a bilateral symmetry. With the continued elongation of the body, the digestive tract, which at first ended blindly, also would elongate and finally acquire a posterior opening at a position directly opposite the mouth. This view, then, supposes the body of the radiate animal to elongate in the direction of its long axis, and a bilateral symmetry to arise in reference to the organs of locomotion.

A second view, advanced by Balfour, while based on the same fundamental principle of stationary and free life, supposes the change to take place in a different fashion. This view supposes that the growth of the free-living radiate form resulted in an elongation, not in the direction of the axis of the animal, but rather at right angles to this axis. This places the mouth of the animal, from the first, not at one extremity but upon one side, which therefore becomes very early the ventral side. The swimming-organs afterwards arose in reference to the already indicated bilateral symmetry.

These two views are fundamentally different. Besides affecting our belief as to the manner in which bilateral symmetry arose, the acceptance of one or the other is the foundation of our understanding of the homologies which are to be found in the two groups.

Evidence for the one or the other of the views is to be looked for in embryology; but very few animals give an opportunity for such research, owing to secondary changes which have acted upon the ova and the embryos. For this reason no direct evidence has been hitherto obtained. At Beaufort, during the last summer, some work was done upon *Thalassema*, a species of worm which possesses a very primitive development, and enables a direct study of the origin of bilateral symmetry from radial symmetry to be made. The results of the observations were satisfactory upon the point in question, and showed that, as far as this group of animals is concerned, the second of the above views, viz. that of Balfour, is in all essential respects correct. The radially symmetrical gastrula elongates nearly at right angles to its long axis, and gives rise to a bilateral larva, of which the ventral surface has been from the first indicated by the position of the mouth. The acquisition of a direct motion occurs some time after the animal is truly bilateral, an indirect revolutionary motion being gradually changed into a direct motion with its anterior extremity in advance.—*Johns Hopkins University Circulars*, April 1883, p. 73.

Observations on Blastogenesis and Alternation of Generations in the Salpæ and Pyrosomata. By M. L. JOLLET.

In 1868 Kowalevsky traced with precision the principal features of the blastogenetic development of the *Salpæ*. According to him the stolon consists, as in the *Pyrosomata*, of two tubes, one within the other, prolonging the ectoderm and endoderm of the parent. In the free space left between them run four cords—two lateral, derived from the cloaca, two median (one inferior, the other superior), derived from two masses of mesodermic cells. According to the same author the skin, the branchio-intestinal tube, and the cloaca of each of the aggregated *Salpæ* are derived from the corresponding parts of the stolon, and, consequently, of the parent; the nervous system and the genital organs, formed at the expense of the median cords, result from the development of two groups of mesodermic cells.

Since this very precise exposition three chief memoirs have appeared upon the same subject; these have again brought into question the whole problem of gemmation and alternation of generations.

Thus, according to Salensky, the inner tube as well as the lateral cords have only a transitory function: the latter are derived from the pericardium; and the intestine is formed at the expense of the inferior cord.

Brooks attributes their real function to the genital cord and the endodermic tube of the *Salpæ*; but he does not recognize a true alternation of generations in the *Salpæ*. Ova being visible in the genital cord of the stolon before the different individuals of the chain are distinct, he concludes from this that the so-called agamic form is a female producing by gemmation not hermaphrodites, but incubatory males, each containing an ovum.

Todaro did not recognize the fact of the original distinctness of the four mesodermic cords; he described a homogeneous middle layer, which, originating from a germoblast, would form the entire body of the bud to the exclusion of the endodermic and ectodermic tubes. As the germoblast is, with him, the equivalent of the ovum itself, the aggregated individuals which originate from it would be, not the sons but the younger brothers of the solitary individual, and there would be in the *Salpæ* neither an alternation of generations nor true gemmation.

My observations enable me to confirm and complete the statements of Kowalevsky; they also compel me to support the old theory of gemmation and the alternation of generations.

If in a very young solitary embryo of *Salpa democratica mucronata* we examine the germinal point, we see a thickening of the ectoderm, against which a diverticulum of the endoderm of the parent abuts internally. In front, towards the placenta, there is a small transparent mass of mesodermic cells, the origin of the neural cord; behind, towards the cloæoblast, another more voluminous one, the origin of the genital cord; and lastly, on each side, a thickening is attached directly by a long peduncle to the lateral lamellæ destined to form the muscles of the solitary embryo; these are the rudiments of the lateral cords. Their connexion with the muscular plates is at first very distinct; subsequently the attachments break and return upon themselves, and it is no longer possible to distinguish any thing of them. Upon this point alone my observations are in disagreement with those of M. Kowalevsky, who makes the lateral cords originate from the cloaca of the parent; the lateral cords, at least in *Salpa democratica*, originate neither from the cloaca nor from the pericardium, but from the muscular lamellæ. In the section of a young stolon the lateral cords appear as two homogeneous cellular masses; later on each of them splits into a hollow cloaca, cord and a mass of mesodermic cells. These cells multiply greatly, and form the lateral or muscular plates of the buds. Further, each segment of the cloacal tube gives origin directly to the cloaca of each bud. As to the central endodermic tube, Brooks is right in his description of the sacs which it emits at each side, and which serve as the origin of the branchio-intestinal tube of the buds. These sacs, enveloped and often masked by the muscular plates, are none the less recognizable in properly made sections.

In the *Salpæ*, as in the *Pyrosomata*, the endoderm, the ectoderm, and the mesoderm of the bud are therefore derived from the corresponding lamellæ of the parent, and serve to form the same organs.

With regard to Brooks's opinions, I have very strong reasons for believing that the genital or inferior cord of the stolon does not serve to give origin solely to the ova or female elements which are seen in the aggregated *Salpa*, but also to the spermatozooids; if, therefore, we are to see in this cord a sexual gland, it will not be a female but an hermaphrodite gland. Hence it follows that the solitary *Salpa* is not a female but an hermaphrodite form.

Moreover, Brooks is wrong in thinking that the ova with germinal vesicle and spot, which are observed already sketched out in the young buds, are true ova. In each bud of *Salpa* or *Pyrosoma* there exists at a certain moment a single one of these bodies; it is seen to divide several times before any fecundation. Only one of these segments becomes the definitive ovum; the others constitute a mass of cells already observed in the *Salpæ* by Leuckart (who was not aware of its origin), and destined to form the proper walls of the oviduct and follicle. There is consequently no reason to be surprised, as has often been the case with reference to the *Salpæ* and *Pyrosomata*, at seeing the ovum precede in development the individual which has to bear it; this body, which nevertheless in its dimensions and constitution presents all the characters of an ovum, is not a definitive ovum, but one of those bodies which the English call "*germinal cell*" and the Germans "*Urei*," and which it may be useful to designate in our language by the name of *proovum*.

To sum up. The gemmation of the *Salpæ* is a true gemmation, but rendered particularly complex by the fact that organs already differentiated take part in it, each on its own behalf.

The solitary form, hitherto regarded as agamic, is not a female; it does not contain an ovary; nor does it contain an hermaphrodite gland, but at the utmost the sketch or rudiment of such a gland; it therefore perhaps merits the denomination of an agamic form.

To avoid all ambiguity it will be well to define the sense which should be attached to this term.

The stock agamic form is that which, produced sexually and possessing sexual tissue, either not yet differentiated and simply in potentiality, or already differentiated and recognizable, *but being incapable of conducting it to the term of its evolution*, confides it for this purpose to one or more successive forms, the last of which at least is sexual.

This formula applies to the *Salpæ*, to the *Pyrosomata* (in which the third bud alone is capable of reproduction), to the *Doliola*, to the compound *Ascidia* (which may present still more complex processes), and, lastly, to several other animal forms.—*Comptes Rendus*, June 4, 1883, p. 1676.

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X.—*Further Contribution to the Knowledge of the Family Tintinnodea.* By Dr. HERMANN FOL*.

[Plate IV.]

A SHORT memoir published two years ago† in this Journal gave an account of the results of my first observations upon the anatomy and classification of this interesting family of Infusoria. Since then another winter passed at Villafranca,

* Translated by W. S. Dallas, F.L.S., from the 'Bibliothèque Universelle: Archives des Sciences Physiques et Naturelles,' période 3, tome ix. p. 554 (15th June 1883).

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- XI. Dr. V. Sterki, "*Tintinnus semiciliatus*, eine neue Infusorienart," Zeitschr. f. wiss. Zool. Bd. xxxii. p. 460, with one plate, 1879.
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- XIV. C. M. Vorce, "Is it *Tintinnus*?" Amer. Monthly Micr. Journ. vol. ii. pp. 223, 224, 1881.
- XV. O. Bütschli (Reporter), Zoologischer Jahresbericht, 1881, erste Abth. p. 151.

† See Ann. & Mag. Nat. Hist. ser. 5, vol. vii. p. 237.

Ann. & Mag. N. Hist. Ser. 5. Vol. xii.

in 1880-1881, has enabled me to resume this investigation at the point where I had left it, and to make a step in advance in the knowledge of the structure of these animalcula.

Some forms occurred which I had not previously met with. Some further details of structure were able to be elucidated. In the natural sciences method plays a principal part; but it is nowhere of greater importance than in microscopical researches: here the fitness of the investigator consists much less in any particular perspicacity than in the art of bringing into view the points that he wishes to know. Hence the employment of a new method has enabled me to see clearly many things which I had previously been unable to see, or which I had seen imperfectly and misunderstood.

I shall consequently have not only to describe new details, but also to rectify my former data in several particulars. The "Bibliographical Index" contains a memoir (XI.) which had previously escaped my notice, upon an Infusory allied to those described by me, as well as some publications, rather of a critical than a descriptive nature, which have appeared since I prepared the "Bibliographical Index" to my previous article [*'Annals,'* vol. vii. p. 250].

Method.—The collection of the Tintinnodea in the sea is an easy matter. There is no danger of damaging them at the moment of their capture, seeing that their test, into which they withdraw at the smallest sign of danger, sufficiently protects them. They are pretty robust, and swim briskly about in the bottles several hours after their capture, and at a time when many delicate animals are already dead or disfigured. It is not, however, at the surface of the sea or under a bright sun that we find them in the greatest abundance. In cloudy weather they rise to the surface more readily than in bright weather; and in the daytime they are found chiefly at a depth of several fathoms.

For their capture I employed a net of fine muslin of a conical form attached to a ring about 50 centim. in diameter. The bottom of the net presents a contracted opening, like that of a wheel, which opens at the middle of a much smaller net made of silken sieve-cloth with very fine meshes. This latter is attached to a ring equilibrated by a fragment of cork. This net of silken gauze does not injure the animals at all; and it captures at least twice as many as the glass bottle which some naturalists substitute for it. It is easy to understand, in fact, that the impermeable walls of the bottle compel the water to turn in its interior, and cause eddies which carry out a considerable proportion of the captured animals.

With creatures so active and so difficult to observe alive

under a high power, it is of great importance to have a process which enables them to be fixed instantaneously in their natural attitude before they have had time to withdraw into their test, and which preserves faithfully the details of their structure.

I have tried the various reagents most in vogue without attaining my purpose. With weak osmic acid I did not succeed in preserving the cilia of the peristome; and with a stronger dose the body became absolutely opaque: in both cases there was always a strong contraction. Acetic acid, chromic acid, and picrosulphuric acid only gave me a fixation which was too slow, so that the animal died contracted in the bottom of its test. Finally I succeeded with a reagent which is not employed in histology, perchloride of iron; by its means I have obtained a considerable number of specimens of various species fixed in a state of full expansion. These subjects, washed with alcohol, and treated with gallic acid, present a brown coloration which is especially localized upon the nuclei and renders them very visible; the other parts of the animal acquire a light brown tint, which renders them easy to see.

The specimens thus treated may be mounted in Canada balsam, which produces permanent preparations; but they are much more distinct and more instructive if simply placed in glycerine.

By treating in the manner just indicated the whole produce of a capture we can afterwards, on returning home, seek at leisure for the Infusoria, a more or less considerable number of which will be fixed in a state of full extension of the body and peristome, with the cilia and the vibratile palettes preserved in perfection.

Anatomy.—The structure of the test is more complete in certain forms, and presents more difference between the forms than I previously supposed. Tests slightly tinged with gallic acid and mounted in balsam or in glycerine are especially instructive. By compressing the test a little we obtain at the margins perfectly distinct optical sections.

Examined under these conditions with a good homogeneous immersion-lens, the tests of the *Tintinni* prove to be composed of two very distinct layers, as I previously indicated (XII. p. 12 [242]); but what I did not see in fresh preparations is that the layers are symmetrically placed, one at the inner, the other at the outer surface, and separated by a vacant space (Pl. IV. fig. 7). The substance of the test, browned by gallic acid, shows very clearly these two parallel layers, apparently of the same thickness throughout their whole extent.

In *Tintinnus ampulla* this thickness is 0.8μ . The space which separates these two laminae is a little thinner than the laminae themselves, and is divided by a number of little secondary partitions which pass from one lamina to the other. The arrangement of these lamellae varies according to the species and produces the design which characterizes the test of each species. At the free margin of the test the two laminae unite by bending round and form only one.

In the genus *Cyttarocyclus* the general arrangement is the same, but the laminae are more separated and the partitions less numerous and stronger, leaving more apparent alveolar spaces (Pl. IV. fig. 10).

Dictyocysta, besides these alveoli, presents perforations of the whole wall.

Lastly, in *Coniocyclus*, which I now think may be united with the genus *Codonella*, the wall is simple, of variable and irregular thickness, and incrustated with foreign bodies.

Hence there are no profound differences except between the agglutinant tests with massive walls and the tests with double walls united by little septa. The latter only differ among themselves by the number and arrangement of the septa; the fundamental structure remains the same. I previously (XII. pp. 18, 22 [245, 248]) described the alveolate tests as formed of a sort of trellis, closed only on one side by a continuous membrane. This statement must be corrected in this respect, that the alveoli are found in all parts and enclosed between two continuous membranes.

The animals preserved by the method indicated show clearly various details of structure which escaped me in the animals treated by the usual methods. In gallic acid the nucleus acquires a dark brown tint, which enables it to be distinguished at the first glance. In *Tintinnus ampulla* and *T. spiralis*, the only two species of the genus that I have met with this time, I have never seen more than a single nucleus, which was of considerable size, and placed either near the middle of the body or further back and towards the peduncle. In my preparations I have also met with many individuals in which I could discover no element of this kind; it is so easy to see when it exists that I incline to believe that in certain phases of existence it is really absent or profoundly modified. In *Tintinnus ampulla* the nucleus is oval, and measures as much as 50μ in its greatest diameter (see Pl. IV. fig. 7). It is formed by a thick superficial layer, which remains homogeneous in the reagents employed (perchloride of iron, alcohol, and gallic acid), and acquires a uniform brown tint. I have been unable to detect any distinct membrane at its surface.

This layer surrounds a rounded cavity $28\ \mu$ in diameter, filled chiefly with a granular matter; we distinguish in it comparatively large granules, which acquire a very dark brown colour and are enclosed in an irregular finely punctate mass.

I have not met with this structure in the nuclei of the other species; but I do not for that reason assert that it is a specific character; I should rather incline to think that this state of the nucleus answers to one of the phases of the existence of our animals. I regret much that I did not this time meet with conjugated individuals; suitably prepared they would have furnished valuable information as to the function of the nuclei during that act.

The sarcode of the body appears to be simply granular, without organization; and, in particular, I have sought in vain for indications of striation or of layers of myoplasin*.

The oral disk and its singular structure particularly attracted my attention this time also; and by means of perfect preparations as regards fixation and preservation I have been able to examine the vibratile circlelet at my leisure and under the highest powers. The results obtained differ considerably from those which were furnished by the laborious observation of living animals.

The general arrangement of the vibratile lines is indeed as I indicated; they are curved lines, about twenty in number, which start from the margin and terminate in the interior of the circle. But these lines are only in part formed by isolated cilia; the outer portion of each vibratile line is composed of pretty broad vibratile lamellæ. These lamellæ are slashed at the free margin and divided into filaments; they undulate in the living animal in such a manner as to give exactly the same image as a row of cilia beating one after the other. This appearance, together with the existence of isolated cilia detached from the margin of the lamellæ, led me into an error, but an error the more excusable because the lamellæ occupy only the margin of the disk, and a series of gradually shortening cilia exists upon the line of each palette.

These undulating palettes acquired such distinct contours in perchloride of iron and gallic acid, that without the observation of the living animal one would think one had to do with cuticular products (Pl. IV. fig. 7). The width of the palettes, moreover, is very variable, according to the genera

* In speaking of the absence of striation in the peduncle of the body, a striation which, on the contrary, appears in the peduncle of the *Forticellæ*, I have used the term "transverse striation." This is a *lapsus calami* which Bütschli has justly pointed out (XV. p. 151); it was of the longitudinal striation that I intended to speak.

and species; and I have remarked that when the palettes are narrow, several large cilia are placed in a row following them. It is therefore very possible that the palettes are to be regarded as representing a series of cilia soldered together. They are not rigid in any of their parts, but absolutely protoplasmic and contractile throughout their whole extent.

Häckel (IX. p. 564, and figs. 8-11) describes his genus *Codonella* as possessing similar vibratile organs; but he represents them as irregular shreds arranged upon the edge of a membrane. I have now observed a form very probably identical with that described by the above distinguished zoologist; and I think I can assert that his interpretation is not correct. In this animal the vibratile lamellæ are narrow; but they have the same general arrangement as in the other Tintinnodea, and are placed upon lines curved into portions of a spiral. Their lateral margins are nearly straight; and their outer margin is divided into cilia. A small number of independent cilia complete the spiral line commenced by each of the undulating palettes. There is consequently nothing in the structure of the vibratile circlet of the *Codonellæ* which justifies their separation as a distinct family from the other Tintinnodea. Moreover these palettes are much wider and more apparent in *Cyttarocyllis cassis* than in *Codonella*. Häckel represents that species as possessing in all only two rows of cilia; if he had seen the palettes, as he saw the much smaller ones of *Codonella*, he certainly would not have placed these animals in distinct families.

I had already concluded my study of the anatomy of these Infusoria, and in particular of their vibratile circlet, when by chance I met with an article by Dr. V. Sterki (XI.)—an article anterior to my first memoir, but which was completely unknown to me. I had the pleasure of finding in it a description entirely conformable with my corrected ideas as to the structure of the ciliary circlet. It is therefore to Sterki that belongs the most incontestable priority upon this point; for Häckel's description cannot be regarded as sufficiently exact.

Sterki's description is also interesting in that it makes known to us a freshwater form, of which the structure is the same as that of the marine species, and which shows that the family Tintinnodea is not confined to salt water. This fact will assist us in judging of Sterki's statements (VIII.) which I have already criticised, and especially of certain synonyms which have been very uselessly introduced (XIII.).

As I have already stated, the vibratile lines include both palettes and independent cilia. These cilia are placed in part

within and in part outside of the palettes; the palette being placed on the summit of the edge of the peristome, the cilia are implanted running downwards from it. Those which are outside the peristome are generally strong and nearly as long as the palettes. I have never found more than a single circle of cilia in this position; it is this that H \ddot{u} ckel has represented in his *Codonella* (fig. 8), but giving them an exaggerated length. According to Sterki (XI.) the freshwater *Tintinnus semiciliatus* has several circlelets of cilia in this position, descending pretty low down upon the sides of the body. The cilia placed in the interior of the peristome are short and thick, becoming shorter as they approach the middle of the disk.

I have been unable to discover, in any of the species that I have observed, the coating of fine cilia which, according to Claparède and Lachmann and H \ddot{u} ckel, covers the outer surface of the body in certain species. I believe I have met with *the same two species* to which the latter ascribes these cilia in his text and in his figures; and I have ascertained that *these cilia do not exist*.

On the other hand, in some species I have met with a structure which I have not satisfactorily succeeded in rendering evident. This is a membrane which proceeds from the body of the animal, being inserted a little below the peristome, and passing thence to the test, to which it is attached along a circular line which occupies about the upper third of the latter. I only infer the existence of this membrane from some images furnished by animals treated with reagents, and in which, moreover, this structure is but rarely preserved; I possess only a single observation made during life, namely upon *Codonella galea*. However, I must add that the images did not appear to me sufficiently clear to be definitely established, and it is a point that I only mention to call the attention of investigators to it. It seemed to me that this membrane is sufficiently ample to permit the complete extension of the animal, and that in the retracted state of the latter it folds in the manner of an Indian-rubber tobacco-pouch, thus completely closing the access to the inner part of the test (see Pl. IV. fig. 14).

In *Codonella ventricosa* (Pl. IV. fig. 12) the free margin of the test is produced into a flexible membranous portion, which opens, in the state of extension, after the fashion of a straight neck, whilst it closes completely when the animal withdraws itself to the bottom of its test, forming a diaphragm over the orifice of the latter. The mechanism by which the animal in retracting itself produces this occlusion can only

be understood if we assume the existence of a delicate membrane starting from this flexible border to become attached around the peristome. I have not seen this membrane; but its existence seems to me probable for the reasons indicated, and by analogy with the species in which the test, being more transparent, has allowed me to see a membrane at the spot indicated.

In *Cyttarocylis cistellula* the margin of the test of adult specimens is also occupied by a prolongation which is less flexible than that of *Codonella ventricosa*, and is generally inclined from without inwards (Pl. IV. fig. 8). It does not appear that this border can shut up completely; and therefore it will only act as a partial diaphragm.

Together with certain common points of structure, the Tintinnodea therefore present a great variety in details, and we must expect in course of time to find a great diversity of forms. Thus, for a few days only, I met with a considerable number of specimens of a species which will be described further on, and which has the habit of attaching its agglutinant test to floating Algæ, which the animal carries about with it.

We know that certain forms which appear to be useful in the struggle for existence are often realized by very different animals and by very diverse means, although the final result may be very similar from the physiological point of view. The Ichthyosaur and the Cachalot, the Pterodactyle, the bird, and the bat are striking examples of this convergence of characters by adaptation. Among marine animals I have shown* that the *Doliolum* of the second generation, with its two kinds of buds, behaves like a Siphonophore, the zoecium being formed of a locomotive individual comparable to the bells of a *Diphyes*, and of feeding individuals or gasterozooids which nourish the whole colony.

Another of these very frequent forms is that of very slender pelagic animals moved by palettes or cilia placed in the middle of their length. The larvæ of the Zoëa-form of certain Decapod Crustacea are a well-known example of this animal form, which may very well be compared to the boats which are used in rowing matches. The great length has no injurious effect upon the rapidity of natation, just the contrary; but it renders all displacement which does not take place in the direction of the longitudinal axis very difficult. However, the animals which possess this external form have a

* Société de Physique et d'Histoire naturelle de Genève, "Sur la nutrition et la reproduction du genre *Doliolum*, communication faite en 1875;" and "Ueber die Schleimdrüse oder den Endostyl der Tunicaten," Morphol. Jahrb. Bd. i. p. 222 (1875).

faculty which makes up for their want of the power of turning; they have the faculty of swimming backwards as fast and as readily as forwards; and, moreover, they can instantaneously change the direction of their course. The long processes with which they are provided, by striking against foreign bodies, warn the animal of danger, and enable it in good time to effect a precipitate retreat. This singular form is realized not only by the Zoëæ which I have just mentioned, but also by a new Infusorian of the family Tintinnodea. In fact this curious species has the habit of applying its test laterally against the cylindrical cells of an Alga furnished with long processes, which, although foreign to the animal, appear nevertheless to fulfil exactly the same functions as the processes of the carapace of the Zoëæ. Each of the cells of this Alga bears a large process directed forwards, another directed backwards, and shorter lateral processes, between which the Infusorian attaches its test (Pl. IV. fig. 15). The number of Algal cells that the *Tintinnus* transports with it varies from one to four.

The *Tintinni* swim with the aperture of the test in front, and have not at all the habit of moving in the opposite direction; if they do so, it is only exceptionally and for a very short time. Our species, on the contrary, swims just as readily in one direction as in the other; and when the anterior point of the Alga meets with a foreign body, the animalcule takes to flight backwards as quickly as it had advanced.

Another example of convergence of types by adaptation is furnished by an Infusorian the description of which I have been unable to find in any author, although the species is not rare. The aborescent colonies of this Vorticellidan float in the sea; and if one touches them, they contract after the fashion of a Medusa, producing a movement of propulsion of the whole colony.

Classification.—In the still imperfect state of our knowledge of this group I think it most prudent to continue to take the characters of the test as the basis of classification; and I consider myself the more authorized to act thus because the differences of the anatomical characters appeared to me to coincide with the sections that we obtain by taking into account only the test.

Genus I. TINTINNUS, Schrank.

Diagn. emend. Test smooth, firm, chitinous, transparent, composed of two lamellæ united by septa which are not very

regular and are placed very close together. A single nucleus in the posterior part of the body. Vibratile lamellæ of the peristome broad, and followed by a considerable number of independent cilia. A circlet of cilia outside the circlet of undulatory lamellæ.

Tintinnus ampulla, auctt. (Pl. IV. fig. 7.)

The inner lamina of the test forms two circular folds at the part where the contours change their direction. The undulatory lamellæ are more powerful in this species than in any of those which I have observed. The vibratile cilia which are implanted in the walls of the œsophagus are particularly powerful and easy to see. The test measures 0.11 millim. in length and 0.1 millim. in breadth. The numbers previously given were erroneous.

Tintinnus spiralis, auctt.

The dimensions that I have indicated for the test in my previous article were not correct, in consequence of an error in the calculation of the magnifying-power. The length of the test is only 0.312 millim. instead of 0.4 millim., and its width at the aperture is 0.068 millim. instead of 0.09 millim.

The two lamellæ of the test are perfectly distinct and united to each other by somewhat irregular septa, which, however, are in general directed from the front backwards with a spiral twist. It is these septa that I formerly described as simple striæ. Between the septa there are longitudinal rows of small points, which are only the optical sections of small pillars passing from one lamina to the other. At the free margin of the test the two laminæ separate a little from one another, thus leaving between them a wider space than elsewhere. Externally the margin of the test is enlarged into a sort of rib, while internally it is regularly cylindrical. The hollow rib is therefore formed by the separation of the outer lamina. The margin itself is hollowed by a furrow produced by a folding of the wall of the test at the spot where the outer lamina passes into the inner one; this circular fold therefore projects into the cavity of the rib, which it diminishes to this extent.

The peristome bears a circlet of undulatory palettes, which I formerly took for isolated cilia. Outside of these palettes it appeared to me that there was only one independent cilium to each spiral series; while within there are several cilia gradually becoming shorter. My specimens, fixed by perchloride of iron and coloured by gallic acid, present a single oval

nucleus, situated laterally against the wall of the body, on the side opposite to that where the buccal aperture is placed, nearly in the middle of the length of the body.

Genus II. CYTTAROCYLIS, auctt.

Diagn. emend. Test smooth, firm, transparent, composed of two lamellæ separated by a space at least twice as great as the thickness of each of the lamellæ. This space is divided by very regular septa into a number of small polygonal alveoli, which give the test a trellis-like aspect.

Peristome fringed with undulatory palettes narrower than in *Tintinnus*.

Cyttarocyliis cassis.

(*Dictyocysta cassis*, Hæck.)

Several hardened specimens presented an oval nucleus, situated about the middle of the length of the body. Fig. 10, Pl. IV. shows the edge of the test, with its septa and its two lamellæ in optical section. The length of the test is 0.22 millim., and its greatest width 0.132 millim.

Cyttarocyliis cistellula, sp. n. (Pl. IV. fig. 8.)

The test is rounded, ovoid towards the bottom, while the upper part widens in the form of a funnel. Upon the edge of the funnel there is a membranous portion directed inwards. This membranous portion encloses a pretty wide sinus, and consists of a very delicate and very flexible membranous outer wall, and of an inner wall which forms the continuation of the inner lamina of the shell.

The cells enclosed between the two laminæ of the test and bounded by the little septa of polygonal form are of nearly equal size, except a certain number of cells placed as a zone around the widest part of the test, which are three or four times as large as the other cells. The small cells (I do not employ the word in its histological sense) are, on the average, $3\ \mu$ in diameter; the largest ones are as much as $9\ \mu$ wide. The length of the test, including the membranous border, attains 0.1 millim.; its greatest width is 0.07 millim. The animal differs but little from that of *C. cassis*.

I met with this species at Villafranca, where it was rather rare during the winter of 1880-81.

Genus III. DICTYOCYSTA, Ehrbg.

Test formed of two lamellæ with septa as in *Cyttarocyliis*, but also presenting true apertures; fenestræ wider than the internal cells of the test.

Dictyocysta templum, Häck. (Pl. IV. fig. 9.)

I think I can identify the species I met with at Villafranca with that of which Häckel has given a figure, notwithstanding the more rounded form of the apex of the test, and notwithstanding some differences attributable to errors of drawing. The test in structure much resembles those of the genus *Cyttarocyliis*, except that the large fenestræ of the margin and those placed around the widest part of the test are really perforated. I ascertained this fact by placing the test in a drop of glycerine charged with suspended particles, and causing the liquid to flow by means of pressure upon the covering-glass. I then saw the particles pass through the fenestræ, while the experiment has always given me negative results in the case of the large cells of the test of *Cyttarocyliis*.

The animal seemed to me to differ very little from that of the latter genus.

This species, the only one of the genus that I have found at Villafranca, only occurred in small numbers.

Genus IV. CODONELLA, Häck.

(*Coniocyliis*, mihi.)

I think I am now sure of the identity of one of the species that I have described under the name of *Coniocyliis* with one of Häckel's *Codonellæ*. The diagnosis of the latter, it is true, is defective, since it is based upon a misunderstood character, which, moreover, is common to the rest of the Tintinnodea. Nevertheless I prefer to retain the name proposed by the above-named author, since that name has the advantage of priority. The following is the new diagnosis of this genus:—

Test formed of a single lamina, uneven, embossed or striate, agglutinant, more or less incrustated with foreign bodies. Animal furnished at the peristome with narrow undulatory lamellæ, and possessing two nuclei.

Codonella campanula. (Pl. IV. fig. 11.)

(*Tintinnus campanula*, Ehrbg.; *T. campanula*, Clap. & Lachm.; *Codonella campanella*, Häck.; *Coniocyliis campanula*, mihi.)

I think I may identify this species with the one figured

and described by Häckel, notwithstanding the few differences that will be remarked in the form and proportions of the test, because I have now arrived at a certainty that Häckel's drawings were made rather carelessly, and must not be taken "au pied de la lettre."

The two nuclei are placed in the hinder part of the body and attached to the two opposite walls. One of them is generally placed a little behind the other.

I profit by this opportunity to rectify my previous statements as to the dimensions of the test of this species. The length of this test reaches 0.16, and its width at the orifice 0.1 millim.

Codonella ventricosa. (Pl. IV. fig. 12.)

(*Tintinnus ventricosus*, Clap. & Lachm.)

The test is much thicker than that of *C. campanula*, and strongly incrustated with small granules of very unequal size. The constricted edge is smooth; and it is upon this non-incrustated part that the flexible membrane is implanted. The smooth zone resembles a cravat, and the membrane a straight collar rising above it. The figure represents this membrane slightly folded. When the animal expands, the membrane becomes elevated in a cylindrical form; when the animal withdraws to the bottom of its test, the membrane folds inwards and completely closes the entrance to the test. This membrane is incrustated with little brilliant elongated bodies, all directed perpendicularly to the edge of the membrane. The test is 0.075 millim. in length to the base of the membrane, which is 0.015 millim. wide. The greatest width of the test is 0.07 millim.

The animal presents two nuclei placed at the same level towards the middle of the body against the walls.

I found this species in very great abundance at Villafranca.

Codonella nucula, sp. n. (Pl. IV. fig. 13.)

This species much resembles the preceding, except as regards its dimensions. The incrusting bodies are a little more scattered, and the flexible membrane is relatively wider. The length of the test alone is 0.04 millim., that of the membrane 0.015 millim., and the greatest width of the test 0.033 millim.

One might be tempted to take this form for a young state of the preceding species, if it were not that, notwithstanding the great abundance in which these two species occur, intermediate forms are entirely wanting. Moreover I have never,

in any species of Tintinnodea, met with smaller and larger tests, which proves that the test is produced of its definitive dimensions from the first, whatever may be the size of the animal secreting it.

The *Tintinnus Ehrenbergii* described by Claparède (X. p. 1) indeed appears to continue to enlarge its test after having secreted it; but this growth is obtained by the addition of rings, which are not in continuity of form with the first portion of the test.

Codonella galea, Häck. (Pl. IV. fig. 14.)

Although the form and the mode of incrustation of the test do not absolutely agree with Hückel's figures, I think I may identify this species with that of the author cited, and this for reasons already indicated in connexion with *Codonella campanula*.

The test is strongly incrustated with large flattened granules, which nearly all touch each other at their edges. The total length of the test is 0.08 millim., its greatest width is 0.06 millim.; its entrance at the level of the constriction may be closed when the animal retracts itself by a folded membrane, which I have indicated in the figure. The folds meet in such a manner that the central point forms a pointed projection.

I abstain from classing and giving a name to the Infusorian which I have found attached to the algæ (Pl. IV. fig. 15), the observation of the living animal not having furnished me with sufficient information as to the structure of the vibratile circle and of the test, and the specimens which I had preserved for examination having been destroyed by an accident. It seems probable, however, that this form is allied to the *Codonellæ*. In most of the specimens that I have met with the apex of the test was broken, so that the test was open at both ends; but this injury does not seem to be the least inconvenience to the animal.

It results from the facts that I have just cited that the organization of the Tintinnodea is not much varied, and that nothing can justify the separation of the genera at present known into several families. I have previously indicated what are my motives for retaining the above name for the whole family. Sterki's memoir is particularly interesting as showing us that the freshwater forms do not differ in their organization from the marine forms, and that there is no

plausible reason for reserving this family name for a hypothetical type founded upon defective descriptions. This, however, is what has been done by Saville Kent (XIII. p. 624), who gives the name of Dictyocystidæ to the Tintinnodea, and suppresses the former name because he has not found animals to which he could apply it. The Dictyocystidæ of Saville Kent are simply a synonym of the Tintinnodea of Claparède and Lachmann, a synonym which we may simply set on one side, since the priority belongs incontestably to the name that I have adopted.

This applies also to the genus *Petalotricha*, which Saville Kent seeks to substitute for the name of *Tintinnus*. Here, again, he seems to reserve this latter name for hypothetical animals. It would be superfluous to combat a prejudice; it suffices to demonstrate it.

The families Dictyocystidæ and Codonellidæ, as Hæckel has established them, have a better claim on our attention; for these are not simple synonyms. These families are founded upon anatomical differences; and it remains only to learn whether these differences are real or whether they are not rather based upon insufficient observations. I pronounce without any hesitation for the latter alternative. The preceding pages show that the organization of our Infusoria does not vary much, and that even in the arrangement of the peristome, upon which Hæckel founded his distinctions, there does not exist any difference sufficient to justify their separation into several families. The genus *Codonella* is the only one that presents well-marked characters, not in its peristome, but in the structure of its test and in the presence of two nuclei at the hinder part of its body. Have these differences more than a generic value? I do not think so, and I regard all the Tintinnodea known at the present day as forming a single tribe and a single family. As regards the position of this family relatively to the peritrichous Infusoria I have already given my opinion, an opinion which my later researches have only confirmed and still more strongly accentuated.

EXPLANATION OF PLATE IV.

- Fig. 7. *Tintinnus ampulla*, treated with perchloride of iron and gallic acid and mounted in Canada balsam. $\times 420$.
 Fig. 8. *Cyrtarocyis cistellula*, the test treated with perchloride of iron and gallic acid and preserved in balsam. $\times 420$.
 Fig. 9. *Dictyocysta temphum*, the test treated like the preceding. $\times 420$.
 Fig. 10. Upper portion of the test, seen in optical section; treated with perchloride of iron, gallic acid, and Canada balsam. $\times 420$.

- Fig. 11. *Codonella campanula*. The body and a part of the test; same treatment. $\times 420$.
 Fig. 12. *Codonella ventricosa*. Same treatment and same enlargement.
 Fig. 13. *Codonella nucula*. Same treatment and enlargement.
 Fig. 14. *Codonella galea*, drawn from the living animal. $\times 420$.
 Fig. 15. New Tintinnodean, drawn from the life and $\times 380$. The correctness of this figure is not guaranteed as regards the ciliary circlet of the peristome, which could only be studied upon living animals.

XI.—*Descriptions of some new Genera and Species of Curculionidæ, mostly Asiatic.*—Part II. By FRANCIS P. PASCOE.

OTIORHYNCHINÆ.

- Isomerinthus interruptus*.
Gynaria, n. g.
 — *nasuta*.

LEPTOPINÆ.

- Stenocorynus vexatus*.

ATTELABINÆ.

- Attelabus corallipes*.
 — *indigaceus*.
Apoderus macropus.

BALANININÆ.

- Balaninus luctuosus*.
 — *galbula*.
 — *cinereus*.
 — *cuneipennis*.
 — *productus*.

CIONINÆ.

- Cionus obesus*.
Nanophyes finitus.
 — *concretus*.
 — *tarsalis*.

ITHYPORINÆ.

- Byrsia*, n. g.
 — *cerata*.

CRYPTORHYNCHINÆ.

- Acacallis* n. g.
 — *personata*.
Miocalles, n. g.
 — *notatus*.
Diphilus, n. g.
 — *squamosus*.
Dipaltosternus Fairmairei.
Osaces, n. g.
 — *nasos*.

ISORHYNCHINÆ.

- Telephæa propola*.

ZYGOPINÆ.

- Asytista antica*.

BARIDINÆ.

- Acythopeus luxatus*.

CALANDRINÆ.

- Eugnoristus niger*.

Isomerinthus interruptus.

- I. ovatus*, rufo-fuscus; prothorace elytrisque vittis albidis, his in medio interruptis, ornatis; pedibus testaceis, parce squamosis. Long. $2\frac{1}{2}$ lin.

Hab. Fiji.

Ovate, reddish brown or chocolate-coloured, with stripes of white scales; rostrum short, scaly, head behind the eyes ob-

liquely striated; antennæ ferruginous, first two joints of the scape a little longer than the others, all tipped with black; prothorax rather coarsely punctate, a stripe of white more or less approximate scales on each side; elytra short, well rounded at the sides, seriate-punctate, the interstices with concolorous scales, the suture with four abbreviated stripes at the base and five at the apex, composed of white scales; legs testaceous, with scattered white scales, more dense on the upperside of the femora and on the tibiæ.

In this well-marked species the scales on the interstices of the elytra are only visible under a strong lens.

GYNARIA.

Rostrum crassum; *scrobes* apicales, arcuatæ, ad oculum currentes. *Oculi* majusculi, rotundati. *Scapus* antennarum ad prothoracem haud extensus. *Prothorax* normalis. *Scutellum* distinctum. *Elytra* ovata, modice convexa. *Mesosternum* angustum, declive. *Pedes* et *abdomen* ut in *Isomerintho*.

This genus differs from *Isomerinthus* in its stout rostrum not narrower than the head, in the shorter scape not, or barely, extending to the prothorax, and in the presence of a scutellum.

Gynaria nasuta.

G. ovata, nigra, granulis nitide nigris squamulisque viridi-metallicis induta; antennis, clava excepta, tarsisque violaceo-squamosis. Long $4\frac{1}{4}$ lin. (♂), 5 lin. (♀).

Hab. Aru.

Ovate, black, studded with small glossy black granules, the intervals with greenish metallic scales; rostrum with a dull black median ridge, the sides with a smaller ridge and rugosely punctate; scape and funicle closely covered with minute violet-coloured scales, the club with a brownish-black pubescence; prothorax narrow, as long as broad, with a black median line bare of scales; scutellum small, somewhat oblong; elytra coarsely striate-punctate, the interstices granulate, the sides margined with rosy silvery-white scales, which are continued onto the prothorax beneath; femora, except the upper part at the base, and tibiæ closely covered with small brilliant green metallic scales; tarsi covered with violet-coloured scales.

Stenocorynus vexatus.

S. obovatus, omnino griseo-squamosus, elytris ampliatis, seriatim punctatis, apice subacutis. Long. 5-5 $\frac{1}{4}$ lin.

Hab. Timor.

*Ann. & Mag. N. Hist. Ser. 5. Vol. xii**

Obovate, entirely covered with greyish scales; rostrum broader towards the apex, the middle with a black ridge, a short impressed vertical line between the eyes; joints of the funicle gradually shorter towards the club; prothorax transverse, sides slightly rounded, scales concealing any punctures; scutellum subtransverse; elytra not broader than the prothorax at the base, but swelling out and rounded at the sides, finely punctate in rows, the apex subacute. Other characters are those of the genus, which is allied to and not unlike our *Tropiphorus mercurialis* and hundreds of other species not very different except in minute structural characters. *S. aridus*, from Lizard Island, approaches the present species in form; but it has, *inter alia*, shorter and stouter antennæ and elytra more coarsely punctate, with some of the interstices raised.

Attelabus corallipes.

A. fere omnino rufo-corallinus. nitidus; elytris striato-punctatis, interstitiis alternis elevatis, spina laterali antica valida, apicem versus infuscata. Long. 3½ lin.

Hab. Cambodia.

Very like *A. bispinosus*, Gyll., from which it differs in being unicolorous, except the dark brown tip of the elytral spine, the absence of the transverse impressed line on the head, and the raised alternate interstices of the elytra. It was one of M. Mouhot's captures.

Attelabus indigaceus.

A. ovatus, fere omnino cyaneus, subnitidus; scutello nigro; elytris antice reticulatis, postice gradatim seriatim punctatis. Long. 4 lin.

Hab. Laos.

Ovate, almost entirely dark blue, slightly glossy; head prolonged behind the eyes; rostrum short, and with the head coarsely punctate; antennæ long, glossy black, the club dull blackish, tomentose; prothorax closely punctate, the sides at the base obliquely striated and nearly impunctate; scutellum quadrate, black; elytra much longer than broad, transversely depressed before the middle, the base with coarse punctures, as if reticulated, the punctures becoming gradually smaller and disposed in rows towards the apex; anterior tibiæ nearly straight; abdomen coarsely punctate.

The nearest approach to this species appears to be *A. cœruleus*, Jek., from North China; but it is much larger and stouter in proportion, and, *inter alia*, the elytra are quite differently sculptured.

Apoderus macropus.

A. fere omnino fusco-cupreus; antennis ferrugineis; prothorace in medio profunde longitudinaliter sulcato, lateribus oblique costatis; femoribus posticis pone abdomen extensis. Long. $3\frac{1}{2}$ lin.

Hab. Sarawak.

Almost entirely dark or brownish copper; antennæ ferruginous, glossy, except the club; head closely constricted behind, nearly impunctate, a deep groove in front continued to the middle of the rostrum, the latter short and much dilated towards the tip, the neck very short; prothorax subconic, tubular at the apex, rising anteriorly into a bilobed gibbosity, the dividing groove continued to the base, the sides above obliquely ribbed; scutellum quadrate; elytra short, parallel at the sides, the shoulders elevated, striate-punctate, interstices of irregular breadth, raised at the base and round the scutellum, the punctures gradually smaller towards the apex; mesosternum grooved between the intermediate coxæ; legs robust; posterior femora extending beyond the abdomen.

The stout femora, the posterior conspicuously extending beyond the abdomen, give this species a different outline from its congeners. The sculpture of the prothorax is very remarkable.

Balaninus luctuosus.

B. breviter ellipticus, niger, pubescens, niveo-maculatus; antennis ferrugineis, articulo secundo funiculi longiore quam primus; elytris brevibus, cordatis. Long. $2\frac{1}{2}$ lin.

Hab. Dorey.

Shortly elliptic, black, with a concolorous pubescence, and snow-white scales condensed in well-defined spots; rostrum longer than the elytra; antennæ ferruginous, second joint of the funicle longer than the first, the rest gradually shorter; prothorax transverse, rounded at the sides; scutellum white, punctiform; elytra short, cordate, an oblong white spot on the suture at the base, a transverse one on each side and behind the middle, and another at the apex, as well as a larger spot at the base of the prothorax on each side, and the anterior margin, as well as the pectus, white; body beneath and legs clothed, the latter more sparsely, with hair-like greyish scales; second abdominal segment shorter than the two next together; femora with an obtuse tooth beneath.

In some respects like the Australian *B. amœnus*, Fab., but larger, the spots and the form different. In *Balaninus* the rostrum varies in length, sometimes irrespective of sex, and

the insertion of the antennæ may be in the middle or nearer the base of the rostrum. It would be misleading to state minutely these and perhaps other characters from a limited number of specimens. A character may be variable in one species and rigidly persistent in another.

Balaninus galbula.

B. ellipticus, squamulis angustis aureo-fulvis maculisque flavis supra tectus; antennis ferrugineis, articulis funiculi a primo gradatim brevioribus; elytris cordatis. Long. 3 lin.

Hab. Dorey.

Elliptic, above with narrow golden-fulvous scales, spotted and striped with pale yellowish; rostrum as long as the body; antennæ ferruginous; joints of the funicle gradually shorter from the first; prothorax conical, slightly rounded at the sides, two pale yellowish stripes gradually diverging posteriorly, and faint traces of an intermediate one, with one spot on each side at the base; scutellum transverse; elytra cordate, with very narrow glossy black striæ, a scutellar spot, five smaller ones on each, and suture posteriorly pale yellowish; body beneath with yellowish-grey scales; second, third, and fourth abdominal segments gradually shorter; femora thinly scaled, each strongly toothed beneath; tibiæ and tarsi ferruginous.

Narrower than the last, and, *inter alia*, differently coloured.

Balaninus cinereus.

B. ovatus, squamulis cinereis fere omnino tectus; antennis fusco-ferrugineis; elytris magis elongatis, cordatis; femoribus infra dente parvo instructis. Long. $2\frac{1}{2}$ –3 lin.

Hab. Tondano, Macassar.

Ovate, closely covered with pale ashy narrow scales; rostrum nearly as long as the body; antennæ brown; first joint of the funicle a little shorter than the next two together, the remainder gradually shorter; prothorax contracted anteriorly, well rounded at the sides, and slightly bisinuate at the base; scutellum punctiform; elytra somewhat elongate-cordate, flattish at the base, with narrow glossy black striæ; second abdominal segment shorter than the next two together; femora with a small tooth beneath.

In form like *B. nucum*, but at once distinguished by its colour.

Balaninus cuneipennis.

B. subellipticus, supra silaceo-squamosus, ferrugineus; elytris cum pygidio cuneiformibus; femoribus infra dente majusculo instructis. Long. 3 lin.

Hab. Tondano.

Elliptic, covered above with light yellowish-brown approximate scales; rostrum not longer than the elytra; antennæ ferruginous; first joint of the funicle as long as the two next together, these two equal; prothorax subconical, slightly rounded at the sides; scutellum punctiform; elytra, with the pygidium, wedge-shaped, with narrow black striæ; body beneath with paler scales; femora strongly toothed; second abdominal segment much shorter than either the third or fourth, its union with the first by a nearly obliterated suture.

This species has an unusual outline, owing to the gradual narrowing of the elytra towards the pygidium; the short second segment of the abdomen is a very remarkable character; it may be sexual.

Balaninus productus.

B. ellipticus, sparse albo-squamosus; scutello niveo; rostro longissimo, bene arcuato; antennis fusco-ferrugineis; femoribus dente acuto armatis. Long $2\frac{1}{2}$ lin.

Hab. Siam.

Elliptic, black, with white hair-like scattered scales; scutellum snowy white; rostrum much longer than the body and strongly curved; antennæ brownish ferruginous, first joint of the funicle much shorter than the two next together; prothorax subconic, rather broad at the apex, closely punctured, the sides rounded; elytra cordate, striate, the interstices slightly convex; legs and body beneath with scales nearly similar to those above, but the side of the mesosternum and of the two basal segments of the abdomen closely covered with white ordinary rounded scales; femora with a sharp tooth beneath.

In my specimen the antennæ are inserted at less than a third from the base of the rostrum, a character probably less remarkable in the male. Of these *Balanini* the last four species are not likely to be confounded with any others, though *B. luctuosus* has several congeners with a somewhat similar coloration; but, as far as I have noticed, the second joint of the funicle longer than the first should be distinctive.

Cionus obesus.

C. nitide niger, parce squamosus; elytris amplissimis, interstitiis alternis elevatioribus, maculis fulvo-squamosis notatis, striis rude punctatis. Long. $2\frac{1}{2}$ lin.

Hab. Madras.

Glossy black, with a few scattered fulvous scales, more numerous on the head and prothorax; antennæ brown, club

as long as the last four joints together; prothorax with some of the scales forming small loose tufts; scutellum oblong; elytra very broad, striate-punctate, alternate interstices raised and dotted at long intervals with compact fulvous tufts; striæ coarsely punctate; first and second abdominal segments depressed, their suture indistinct.

Larger than *C. verbasci*, with broader elytra. The club is unusually large, and is as long as the funicle without the basal joint.

Nanophyes finitus.

N. ampliatus, fulvus, nitidus, sat parce pubescens; elytris obsolete striatis, pube in maculis oblongis condensatis; clava antennarum articuloque ultimo tarsorum apice nigris. Long. $1\frac{1}{2}$ lin.

Hab. Sarawak.

Glossy fulvous, sparsely pubescent, elytra obsoletely striated; rostrum finely ribbed, mandibles brown; antennæ fulvous, apical half of the club black; eyes nearly contiguous; prothorax conical, equally pubescent; elytra obsoletely striate, an oblong patch at the base and three or four at the sides, of condensed pubescence; body beneath and legs pale fulvous; all the femora with three or four slender spines beneath.

My unique specimen, probably a male, has clearly six joints to the funicle; the seventh may be closely united to the club. In what I take to be *N. nigrifolius* of Boheman (but my example is from Macassar) I should, in any other case, have described the funicle as seven-jointed, the two joints in question being perfectly distinct, although much larger than the others. In departing from the normal condition nature is often very unsteady.

Nanophyes concretus.

N. ampliatus, niger, nitidus, pube grisea laxè tectus; scapo antennarum rostroque ferrugineis; elytris latis, tenuiter striatis, interstitiis planatis. Long. $1\frac{1}{2}$ lin.

Hab. Macassar.

Broad, glossy black, with a loose greyish pubescence; rostrum and scape ferruginous; femora at the base and basal third of the tibiæ pale yellowish; antennæ, except the scape, glossy black; funicle of six joints, club apparently of four; prothorax short, conical; elytra a little longer only than the breadth, slightly convex, finely striate, the interstices broad and flat; legs pubescent; femora with one long spine beneath and two or three much smaller ones.

This species has also a six-jointed funicle, the basal joint of

the club being probably the seventh; otherwise the latter has four joints, the last, however, not being quite so distinct as the three preceding. In this species the femora at about a quarter their length from the base are so constricted as to appear to be composed of two parts. The same peculiarity may be noticed in some European species, e. g. *N. siculus*, *globulus*, *posticus*, &c.

Nanophyes tarsalis.

N. ovatus, niger, nitidus, pube grisea sparse tectus; rostro nigro; scapo fulvo; elytris modice elongatis, striatis, interstitiis convexis. Long. $1\frac{1}{4}$ lin.

Hab. Bourou.

A narrow species with a black rostrum, the elytra with coarser striæ and narrower and convex interstices; the legs, and especially the tarsi, considerably longer; there is the same peculiarity of antennæ and femora; and the rostrum, as in the two preceding, is bicanaliculate anteriorly.

These three species of *Nanophyes*, and some other forms here described, were collected by Mr. Wallace some twenty-five years ago. Recent collectors appear to care little for "small game," whilst this distinguished naturalist neglected nothing, however insignificant to the ordinary collector*.

BYRSIA.

Rostrum tenuatum, arcuatum, fere denudatum; *scrobes* maris medianæ, feminæ basi propriæ, laterales. *Oculi* rotundati. *Antennæ* graciles; *scapus* clavatus; *funiculus* longiusculus, articulo primo longiore et crassiore; *clava* distincta, breviter ovata. *Prothorax* transversus, antice breviter constrictus, lateribus ampliato-rotundatis, basi subsinuatus. *Scutellum* distinctum. *Elytra* subcordata, prothorace basi latiora. *Pectus* excavatum. *Coxæ* antice contiguæ. *Mesosternum* angustum, declive. *Abdomen* segmentis duobus basalibus ampliatis, sutura in medio obsoleta. *Processus* interfemoralis latus, truncatus. *Pedes* normales; *femora* mutica; *unguiculi* liberi.

In Lacordaire's arrangement this genus would stand near *Colobodes*, unless he placed it as an exception elsewhere—perhaps by *Eriirhinus*. The excavated pectus blocked behind by the contiguity of the anterior coxæ is a character that is found in some of the Ithyporinæ. The species described below is closely covered with waxy-looking scales.

* Mr. Wallace's collection from the Malay archipelago, now in my possession, amounted to about 900 species, few of which were previously known. Many of these are described and figured in the Journal of the Linnean Society (Zoology, vols. x., xi., and xii.) and in these 'Annals.'

Byrsia cerata.

B. ovata, castanea, squamulis stramineis vel albidis omnino dense vestita; elytris in medio maculâ infuscata notatis; rostro nitide castaneo. Long. $2\frac{1}{2}$ lin.

Hab. Queensland.

Ovate, chestnut-brown, everywhere, except the rostrum, covered with straw-coloured or whitish scales; each elytron in the middle with a (more or less) brownish spot; rostrum glossy chestnut, with a few scales only at the base; antennæ ferruginous, the funicle with the first joint clavate and longer than the second; prothorax convex, full and rounded at the sides, a well-defined depression at the base; scutellum rounded behind; elytra moderately convex, rather gibbous at the shoulders; the striæ apparently nearly obsolete; beneath and legs densely scaled.

ACACALLIS.

Rostrum breviusculum, rectum, depressum; *scrobes* medianæ, laterales. *Oculi* subrotundati, infra angulati. *Antennæ* breviusculæ; *scapus* versum apicem gradatim incrassatus; *funiculus* articulo primo ampliatus; *clava* majuscula. *Prothorax* transversus, antice subito contractus, basi truncatus. *Scutellum* parvum. *Elytra* modice convexa, prothorace haud latiora. *Rima* pectoralis, pone coxas anteriores terminata, apice aperta. *Abdomen* segmentis duobus basalibus ampliatis; processus interfemoralis apice acuta. *Femora* et *tibiæ* compressæ, illa infra canaliculata, anteriora majora; *tarsi* modice elongati; *unguiculi* liberi.

The straight depressed rostrum, canaliculate femora, and the truncate base of the prothorax are, singly or together, characters which differentiate this genus from *Orochlesis*, *Niconotus*, *Sympedius*, and others belonging to the same group. The pattern on the base has a resemblance to the face of some animal.

Acacallis personata.

A. lata, lateribus parallela, fusca, pallide griseo-variegata; antennis ferrugineis; pedibus parce squamosis, anterioribus multo majoribus. Long. 2 lin.

Hab. Queensland.

Broad, moderately convex, parallel at the sides; prothorax, except a little at the base, a triangular patch on the suture (not extending much beyond the middle), and apical margin pale greyish with a slight pinkish tint; rest of the elytra, including an oblong spot on each side of the triangle at the base, chocolate-brown; antennæ ferruginous, first and second

joints equal in length; prothorax very transverse, the anterior half almost abruptly rounded and ending in a short tubular apex; scutellum round; elytral striæ covered by the scales; legs pitchy, with a few scattered scales.

MIOCALLES.

Rostrum latiusculo vel depresso et *prothorace* apice producto, caput occultante ab *Acalles* differt.

Acalles as it now stands is a collection of genera, and defies definition, although Lacordaire hesitated to separate it from *Tylodes*. The two characters given above, however, are foreign to all the typical members of the genus. The type is a prettily marked little species, which is not true, as its name implies, of any *Acalles*.

Miosalles notatus.

M. ovatus, griseo- et fusco-squamosus, supra pedibusque spinulis erectis fuscis: elytris basi maculis elongatis albis ornatis. Long. $1\frac{1}{2}$ lin.

Hab. Aru, Mysol.

Ovate, covered with grey and brown scales, the prothorax, elytra, and legs with dark brown erect squamiform spines; the rostrum; antennæ, middle of the prothorax, and two linear spots at the base of the elytra white, a band behind the middle paler; prothorax longer than broad, rather gibbous in the middle, and slightly grooved; elytra striate-punctate, the second interstice elevated and carrying the white scales at the base, and followed by dark brown scales as far as the band; body beneath black, with fewer scales.

In the specimen from Mysol the white is replaced by greyish.

DIPHILUS.

Rostrum breve, latum, depressum, fere rectum; *scrobes* medianæ, laterales. *Oculi* ovati, grosse granulati. *Antennæ* crassiusculæ, *funiculus* articulis duobus basalibus æqualibus; *clava* distincta. *Prothorax* apice productus, lateribus subcarinatis. *Scutellum* parvum. *Elytra* convexa, prothorace haud latiora. *Rima* pectoralis pone coxas anteriores terminata, apice cavernosa. *Metasternum* brevisculum. *Abdomen* segmentis basalibus ampliatis, sutura acuta separat. *Femora* et *tibiæ* compressæ, illa mutica, et infra canaliculata; *tarsi* articulis duobus basalibus parvulis, angustis, tertio fortiter bilobo; *unguiculi* liberi. *Corpus* haud setosum.

Among the well-known forms of *Cryptorhynchina* this

genus may perhaps be best compared in superficial resemblance to *Euthyrhinus*, to which, however, except as a member of the same subfamily, it cannot be said to be allied. The prothoracic ridge is formed by an abrupt deflection at the sides posteriorly. The scales overlap one another as in a fish.

* *Diphilus squamosus*.

D. ellipticus, griseo-squamosus, prothorace in medio lineis duabus fuscis, postice divergentibus; antennis ferrugineis. Long. $3\frac{1}{2}$ lin.

Hab. Siam.

Elliptic, covered with greyish overlapping scales; two dark brown stripes, beginning at the apex of the prothorax, diverging towards the base; antennæ ferruginous; scape gradually thicker from the base, the two basal joints of the funicle equal in length, the remainder very transverse, club as long as the last five joints together; prothorax transverse, narrowed and slightly bilobed at the apex, then incurved and rounded to the base, two dark brown stripes, nearly contiguous anteriorly, but gradually diverging behind; scutellum black, not scaly, inconspicuous; elytra convex behind the base, roughly striate-punctate, obtusely apiculate, ridged at the suture posteriorly; interstices more or less tuberculate; the two basal segments of the abdomen with approximate scales, the posterior angularly dilated on the outer edge.

Dipaltosternus Fairmairei.

D. late ovatus, crassus, squamulis griseis fuscisque dense tectus; elytris striatis, antice impunctatis; tibiis intermediis dente valido in medio extrorsum armatis. Long. 4 lin.

Hab. Fiji.

Broadly ovate, stout, closely covered with grey and brown scales, the latter in indefinite spots and patches; rostrum pitchy at the apex; antennæ glossy ferruginous, second joint of the funicle longer than the first, the rest transverse; prothorax feebly bilobed at the apex, the disk somewhat irregular and with four small tufts of erect brown scales; scutellum distinct; elytra slightly broader than the prothorax at the base, the shoulders rather angular, striate, striæ narrow, impunctate at the base, but with shallow punctures or impressions posteriorly; body beneath glossy black, with small scattered scales; fore tibiæ longest, straight, the intermediate with a prominent tooth at the middle externally.

If I am right in referring this species to M. Fairmaire's genus, it differs from his *D. insidiator* in the absence of granules and tubercles on the elytra, and in their nearly im-

punctate striæ (which, however, are almost hidden by the scales) and other characters. M. Fairmaire compares it to *Psepholax*; but its deep pectoral canal, bounded behind by the mesosternum, and its well-marked metasternal episterna would, in Lacordaire's arrangement, place it near *Oreda*.

OSACES.

Rostrum crassum, breve, arcuatum, apicem versus gradatim latius; *scrobes* subapicales, laterales. *Oculi* rotundati, grosse granulati. *Antennæ* crassiusculæ; *funiculus* articulis duobus basalibus æqualibus. *Prothorax* normalis, basi subtruncatus. *Scutellum* parvum. *Elytra* modice convexa, prothorace paulo latiora. *Rima* pectoralis pone coxas anteriores terminata, apice aperta. *Metasternum* perbreve. *Abdomen* segmento secundo modice ampliato, a primo sutura recta separato. *Femora* compressa, infra canaliculata; *tibiæ* breves, striatæ; *tarsi* paulo dilatati; *unguiculi* liberi. *Corpus* modice convexum.

This genus is represented by a species closely resembling the Mexican *Mæmactes ruficornis*, but which differs, *inter alia*, in not having the femora grooved beneath nor the tibiæ striated. The body is naked except a solitary scale in many of the punctures.

Osaces naso.

O. ellipticus, niger, subnitidus; *antennis* ferrugineis; *rostro* grosse, capite gradatim sat vage et leviter punctatis. Long. 3 lin.

Hab. Port Bowen.

Elliptic, black, and slightly glossy; *antennæ* ferruginous, first two joints of the funicle equal, the remainder transverse, club ovate, distinct; *rostrum* coarsely punctate, the punctures gradually decreasing in size and proximity on the head; *prothorax* not longer than broad, rounded at the sides, closely and coarsely punctate; *elytra* substriate-punctate, punctures very large, the interstices with small punctures; body beneath and legs pitchy brown, with small approximate punctures; anterior femora with the groove disappearing beyond the middle; *striæ* on the *tibiæ* closely punctate.

Telephæa propola.

T. anguste ovata, nigra, pilis albidis sat parce vestita; *antennis* pedibusque ferrugineis; *prothorace* vix latiore quam longiore. Long. 1 lin.

Hab. Sarawak.

Narrowly ovate, black, with somewhat dispersed whitish hairs; *antennæ* and legs ferruginous; *prothorax* scarcely

broadier than long, closely punctate; elytra striate, hairs more numerous at the base, middle, and apex, the two interspaces band-like; anterior femora very large, the tooth greatly produced.

This species is much narrower than any of its congeners.

Asyteta antica.

A. ovata, fusco-niger, opaca; prothorace antice albo; rostro in medio leviter punctato; elytris rugosis, granulatis. Long. $2\frac{3}{4}$ lin.

Hab. Kaioa.

Ovate, dull brownish black; rostrum slightly curved, the lower half with small sparse punctures; antennæ rather dull ferruginous; prothorax finely punctured, anterior portion, except at the apex, covered with white or greyish scales, extending to the sides; elytra seriate-punctate, interstices granulate, the third raised, especially at the base; body beneath and legs with scattered white scales.

In the genus *Asyteta* the intermediate and, to a much greater degree, the posterior coxæ are widely apart; the first abdominal segment is as large as the rest together, overlapping and nearly hiding the second. The mesosternum is so short that the anterior and intermediate coxæ are nearly contiguous on each side. The species described above is easily recognizable by the white band on the prothorax.

Acythopeus luxatus.

A. subovatus, niger, subnitidus; prothorace macula utrinque elytrisque vittis duabus ochraceis squamosis notatis. Long. 2 lin.

Hab. Labuan.

Subovate, black, slightly glossy; prothorax on each side with an oblong spot and the elytra with the third interstice, except at the apex, covered with ochre-yellow scales; rostrum roughly punctate; antennæ pitchy; prothorax transverse, subquadrate, closely punctate; pectus, spots on the sternum and sides of the abdomen ochre-yellow.

The species is differentiated by its shorter elytra as well as by its ochreous spots and stripes.

Eugnoristus niger.

E. elongatus, glaber, niger, subnitidus; prothorace elongato, elytris latiore, subtiliter confertim punctulato. Long. 4 lin.

Hab. Madagascar.

Elongate, smooth, black, slightly glossy; rostrum slender, not longer than the prothorax in the female; antennæ slender, the basal joint not longer than the three next together; pro-

thorax much longer than broad, closely and finely punctate; scutellum narrowly triangular; elytra wedge-shaped, narrower than the middle of the prothorax and about a third longer, striate-punctate, the punctures approximate; body beneath finely punctate, except the last three abdominal segments; legs glossy black.

Form, colour, and absence of scales will at once distinguish this species from its only congener, *E. monachus*, Ol.

XII.—On some *Lepidoptera* from the *Victoria Nyanza*.

By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

IN a small collection recently made by the Rev. James Hannington, I find not a few species of great interest; amongst those already known to science may be mentioned *Salatura dorippus*, both with and without an oblique subapical series of small white spots across the under surface of the primaries; a worn example of *Charaxes saturnus*, specimens of which species we have from the Zambesi, the Congo, and Delagoa Bay; *Junonia micromera*, a common Abyssinian species; the Southern *J. cloantha* and *J. pelagis*; a splendid male of *Crenis rosa*, the female of which was described from Delagoa Bay; *Acræa neobule*; *Acræa acara*; *Ypthima simplicia* of Abyssinia; *Myrina pallene*, described from Caffraria; *Aphnæus natalensis*; *Teracolus hetera* ♀?; *T. casta* ♂, *T. maimuna*, agreeing with examples from Angola; *Papilio corineus*; *Ismene anchises*; and a *Saturnia** very near to *S. dyops* of Natal.

It will therefore be seen that there is in this collection a decidedly South-African element—a fact even more strongly brought out by the affinity of the new species to Southern forms.

RHOPALOCERA.

1. *Ypthima granulosa*, sp. n.

Above similar to *Y. simplicia*, excepting that the wings are more rounded and the ocellus on the primaries is smaller and narrower; smoky grey, the primaries paler towards apex and with a well-defined arched darker submarginal stripe, a

* The specimen is in bad condition and completely disguised, the pattern of one wing being printed off upon the other; the ocelli on the under surface of primaries upon the costal border of secondaries above, as well as part of the discal band beyond them.

small oval bipupillated black ocellus with stramineous iris and dusky zone. Wings below quite different from *Y. simplicia*, the general tint being a pale granite-grey colour densely mottled with olivaceous grey; the primaries, however, excepting towards the apex, are suffused with smoky grey, the ocellus is a little larger than above; on the secondaries there are four widely separated minute oval ocelli (only visible with a lens, though perfectly formed), two towards apex and two towards anal angle. Expanse of wings 34 millim.

Victoria Nyanza.

2. *Hypolimnias alcippoides*, sp. n. .

Nearly allied to *H. misippus* (both sexes of which we have from Sierra Leone and Madagascar), but with the inner or abdominal margin of the secondaries in both sexes longer; these wings in the female with the whole of the disk snow-white, as in *Salatura alcippus*. Expanse of wings, ♂ 76 millim., ♀ 74 millim.

Victoria Nyanza.

A second form of female, which although differing somewhat from *H. inaria* must, I think, be a small race of that species, occurs also in the same locality.

This is another instance of a Lepidopterous insect scarcely distinguishable in the male sex from its nearest ally, whereas the female can be separated at a glance; there is little doubt that eventually the male will have inherited enough of the characters acquired for the protection of the female to be more readily distinguished, as in the case of the various local races of *Papilio merope*, the males of which, though very similar, do differ in pattern. In the present instance, where the colouring of *Salatura chrysippus* has been exchanged for that of *S. alcippus* in the female, that of the male still remains in its normal state.

3. *Telchinia nero*, sp. n.

♀. Pale smoky brown above, the wings with black borders a little broader than in *T. oncaea*, the apex of the primaries being especially broadly bordered; numerous black spots arranged exactly as in *T. oncaea*; secondaries with a sub-marginal band, from the radial to the submedian vein, of four snow-white quadrate spots, only separated by the nervures. Under surface like *T. oncaea*. Expanse of wings 52 millim.

Victoria Nyanza.

4. *Telchinia perrupta*, sp. n.

Allied to *T. manjaca* of Madagascar, but the male differing

(as *T. Buxtoni* from *T. eponina*) in the abbreviation of the subapical band to a mere spot or irregular dash across the discocellulars; the female also differs in the same character and also in having the subapical oblique patch white instead of tawny. Expanse of wings 47–53 millim.

Victoria Nyanza.

The marginal tawny spots are well defined in both sexes as in *T. manjaca*, unlike those of *T. Buxtoni*.

5. *Acræa arcticincta*, sp. n.

Nearly allied to *A. anemosa*, from the Zambesi and Natal, from which it differs in having the black external border of the secondaries of only half the width, as in *A. acara*. Expanse of wings 64 millim.

Victoria Nyanza.

6. *Alæna interposita*, sp. n.

Nearest to *A. nyassæ*, but in some respects more like *A. amazoula*. Primaries above smoky grey, with two spots in the cell and an increasing angulated belt from the costa just beyond the cell to the centre of inner margin white; veins black; fringe spotted with white: secondaries grey, spotted with white towards the base, and with two series of pale spots on the external area, the disk occupied by a broad irregular white patch; veins on the grey areas black; body blackish. Wings below cream-coloured, the discoidal area of primaries, basal area of secondaries, and external areas of all the wings reticulated with black; the subapical area of primaries and centre of secondaries pale sandy yellowish; legs yellowish; venter whitish banded with black. Expanse of wings 31 millim.

Victoria Nyanza.

7. *Teracolus aurigineus*, sp. n.

Nearest in colouring to *T. gaudens* from Abyssinia, but intermediate between *T. vesta* and *T. Hewitsoni*. Wings above brilliant golden orange (or cadmium-yellow), with the veins and external borders black; a marginal series of orange dots which, towards the apex of primaries, are elongated into narrow dashes; fringe whitish: primaries with basal fourth creamy whitish, suffused at the base with pale bluish grey; costa blackish; a large black transverse spot closing the cell; the usual bisinuated black discal stripe from costa to inner margin: secondaries with the discal stripe reduced to an angulated series of sagittate spots, punctiform in the male, but large and subconfined in the female: body blackish. thorax

clothed with grey hairs. Under surface only differing from *T. Hewitsoni* in the less diffused and brown markings across the secondaries. Expanse of wings, ♂ ♀ 44 millim.

Victoria Nyanza.

This is a very beautiful and most interesting link between the *T. vesta* and *T. chrysonome* groups; as it retains the discal stripe (although in a somewhat interrupted form) across the secondaries it must be placed between *T. catachrysops* and *T. Hewitsoni*, the order of the species being:—1. *T. amelia*; 2. *T. mutans*; 3. *T. argillaceus*; 4. *T. velleda*; 5. *T. vesta*; 6. *T. catachrysops*; 7. *T. aurigineus*; 8. *T. Hewitsoni*; 9. *T. gaudens*; 10. *T. chrysonome*. With the exception of the Abyssinian *T. velleda* we possess all these species in the Museum.

The following species is still more interesting, since it supplies a link long wanting between the *T. cypræa* and *T. vesta* groups; I have great pleasure in naming it after its discoverer.

8. *Teracolus Hanningtoni*, sp. n.

♀. A little smaller than *T. vesta*: white, slightly tinted with sulphur on the upper surface; both in pattern and coloration above greatly resembling the white female of the Ceylonese *T. modestus*, though much larger; a careful comparison, however, shows that in detail the pattern corresponds more nearly with that of *T. mutans*; the spots upon the broad black border of primaries, however, are almost wholly obliterated, and the arched decreasing series across the disk is composed of spots as small as in the male of *T. mutans* (i. e. rather larger than in *T. amelia*). The under surface is most like *T. vesta*, but very different, the wings being bright sulphur-yellow, the primaries with the basal two fifths suffused with orange; a small black spot at the end of the cell; external border blackish brown, olivaceous at apex, interrupted by two series of sulphur-yellow spots, the inner series interrupted and angulated, the outer series straight, decreasing; the usual spot connected with the border on the interno-median area: secondaries with the basiabdominal area sprinkled with orange scales; veins brown, a slender irregular oblique chocolate-brown line across the basal third; external half chocolate-brown, crossed by two series of large sulphur-yellow spots, one discal, the other marginal: body below white. Expanse of wings 44 millim.

Victoria Nyanza.

T. Hanningtoni must be placed between *T. intermissus* and *T. amelia*.

9. *Teracolus miles*, sp. n.

♂. Above almost exactly like the male of *T. dirus* from Kurrachee; but the base much less grey and the marginal spots smaller than in the type of that species*; no spots on the disk of secondaries above. Under surface milk-white; wings with black longitudinal dashes at the extremities of the veins; an irregularly arched discal series of black spots across the disk of the wings, the first five spots of primaries being placed upon a brick-red nebula and the fourth of secondaries divided in the centre, where there is an orange dot; discocellular spots black, those of secondaries with an orange centre; apical area of primaries cream-coloured; edge of costal margin of secondaries towards the base tinted with saffron-yellow: body below white. Expanse of wings 49 millim.

Victoria Nyanza.

This species must be placed between *T. eupompe* and *T. dirus*.

10. *Teracolus subvenosus*, sp. n.

Nearly allied to *T. gavis* of Wallengren, from South Africa, but the male above nearly as in *T. hero*, the orange-red area of primaries broader at its lower extremity, not black-edged internally; the black marginal spots of secondaries large and confluent; internal streak of primaries and base of secondaries grey, diffused, nearly as in *T. hero*†. Wings below exactly as in *T. gavis*; the female above with the subapical oblique black stripe broad, as in *T. hero* ♀, but the spots between it and the border small and bright orange; the interno-central area of secondaries paler than in either *T. gavis* or *T. hero*: under surface as in *T. gavis*, but brighter in colour. Expanse of wings, ♂ ♀ 48 millim.

Victoria Nyanza.

11. *Teracolus cinctus*, sp. n.

♂. Allied to *T. interruptus*. Upper surface milk-white, external border rather broadly black with dentate-sinuate inner edge: primaries with the costal margin narrowly edged with black; base and a clavate internal streak grey; a black dot at the end of the cell; apical two fifths bright orange, bounded internally by an oblique narrow black stripe and externally by the black border, and crossed by slender black veins: secondaries with the base grey. Primaries below white;

* See P. Z. S. 1876, pl. vii. fig. 12 ♂.

† P. Z. S. 1876, pl. vi. fig. 12 (numbered incorrectly 11).

the apical area broadly sulphur-yellow, suffused internally with orange; a black dot at the end of the cell; a conspicuous interno-median black spot corresponding with the clava to the internal streak of the upper surface: secondaries white, tinted with sulphur, basal third of costal margin bright orange; a small black and orange discocellular spot; a black-speckled yellow costal spot and three similar spots on the disk (on the interno-median, second median, and radial interspaces); veins of all the wings terminating in black marginal dots. Expanse of wings 28-42 millim.

Victoria Nyanza.

12. *Papilio lurlinus*, sp. n.

♂. Nearly allied to *P. antheus*; pale emerald-green and black above, paler green, bronze-brown, black, and grey below, one or two carmine markings on both surfaces. It differs from *P. antheus* in the greater width of all the green markings on both surfaces, the irregular bands across the cell of primaries and the submarginal spots on all the wings being of about double the width; the greyish submarginal streaks on the secondaries are also distinctly wider; the carmine spot at the extremity of the abdominal fold is reduced to a mere dash at the extremity of a longitudinal fusiform white streak; the borders of the primaries below are more distinctly spotted with black; the black spots across the disk of secondaries are decidedly smaller; the black spot above the cell is more elongated transversely and has a narrower carmine border; and the carmine spot in the cell is almost wholly replaced by a larger black spot. Expanse of wings 101 millim.

Victoria Nyanza.

This insect is nearly as large as the female of *P. antheus*. Its natural position is between *P. antheus* and *P. nyassæ*.

HETEROCERA.

13. *Hypercompa tigris*, sp. n.

Allied to *H. bellatrix* and *H. Thehwalli*; most like the former, but the primaries of a paler yellow colour, with all the plumbaginous bands narrower, the second from the base arched, and the fourth much less distinctly angulated: secondaries with no band across the basal area, and the other markings narrower. Expanse of wings 69 millim.

Victoria Nyanza.

14. *Copaxa Hanningtoni*, sp. n.

Creamy sulphur-yellow; primaries above with a small dull

plum-coloured rounded spot with greyish pupil at the end of the cell, followed by an irregularly sinuated slender ferruginous line across the centre of the wing; a second broader straight line runs obliquely across the disk from the inner margin to near the apex: secondaries with indications of a brown line from the abdominal margin to about the centre of the disk, where it entirely disappears: face and front of anterior legs plum-coloured; antennæ red-brown. Primaries below with the ocellus smaller than above, but with a larger and whiter pupil; the inner sinuated line obsolete; the discal line on the secondaries more distinct than above: body below whiter. Expanse of wings 88 millim.

Victoria Nyanza.

Allied to *C. flavinata*.

XIII.—*Descriptions of two new Species of Milionia, a Genus of the Lepidopterous Family Euschemidæ*. By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

THE two following species were recently obtained. Although allied forms and of opposite sexes, they differ, in my opinion, far too much to admit of their being sexes of the same species. Unfortunately we have no more exact locality than "Celebes;" and therefore the probability that they occur in different islands of the Celebes sea, or, at any rate, come from different parts of the large island, must remain for the present unestablished.

Milionia Drucei, sp. n.

♂. Wings above velvety black, shot with deep ultramarine blue; a large spot of cobalt-blue close to the base of the primaries; these wings are also crossed in the middle by a broad and tolerably regular deep-orange belt, which changes to vivid scarlet below the internervular fold of the interno-median area; secondaries crossed in the middle by a vivid scarlet belt: body purplish; the head, collar, tegulæ, and sides of abdomen spotted with emerald-green. Wings below greyer than above, excepting towards the base, where they are suffused with brilliant ultramarine and broadly streaked with emerald-green; belts as above: body ash-grey varied with blackish; legs streaked with green; anal tuft pale stramineous above, blackish below. Expanse of wings 70 millim.

Celebes.

I have much pleasure in dedicating this beautiful species to my friend Mr. Herbert Druce. That gentleman kindly reminded me of the fact that Walker had described a species of this group from Mr. Saunders's collection. Upon looking up the description of Walker's *M. cyaneiferu* from Batchian and Ceram, hitherto undetermined by me, I find that it answers admirably to Cramer's species *M. glauca*. It is extremely probable that Walker would describe the latter species in his Supplement, since in his Catalogue he identified *M. lativitta* and *M. zonea* of Moore as opposite sexes of Cramer's species, and spoke of the typical *M. glauca* as var. β , suggesting that it might be a distinct species.

Milionia Snelleni, sp. n.

♀. Less brilliant in colour than the preceding; primaries with the subbasal spot larger, more diffused, and bright ultramarine blue, the belt across the wings much further from the base, arched, wider, cadmium-yellow, sprinkled at its inferior extremity with vermilion scales; secondaries with the belt much wider, much nearer to the outer margin, its inner edge widely waved or subsigmoidal, colour vermilion; basal area below narrowly streaked with bright blue. Expanse of wings 70 millim.

Celebes.

This is not at all likely to be the female of *M. Drucei*, since the species of this genus are unquestionably alike in the sexes, whereas these two differ far more than some of the known species. *M. Drucei*, in the banding of the primaries, approaches *M. requina*, Quoy (= *M. optima*, Walker, = *M. flam-mata*, Vollenh.), whereas *M. Snelleni* has a band more nearly resembling that of *M. glauca*, though broader and more arched. I have named this species after Herr Snellen, the author of a long paper on the Lepidoptera of Celebes in the 'Tijdschrift voor Entomologie,' 1978-81.

XIV.—On Rudimentary Wings in the Coleoptera.

By Dr. H. DEWITZ*.

THE hind wings of the Coleoptera show us most distinctly how an organ may gradually become aborted by disuse, and how a transformation of the whole habit of the animal may

* Translated by W. S. Dallas, F.L.S., from the 'Zoologischer Anzeiger,' no. 141, June 18, 1883, p. 315.

be connected with this. The membranous hind wings of beetles, which serve for flight, lie, as is well known, concealed beneath the firm horny fore wings, the so-called elytra. For the purpose of flight the elytra are raised and the folded hind wings extended, so as often to exceed the former in length. But many beetles do not fly at all. In these we find the hind wings more or less aborted or entirely deficient. This phenomenon occurs with especial frequency among the Carabidæ, Melasomata, and Curculionidæ, and also, although less frequently, among the Ptinidæ.

Thus, for example, while in *Melolontha vulgaris*, Fab., the length of the body without the antennæ amounts to 0·03, that of the fore wing to 0·02, and that of the hind wing to 0·03 metre, these measurements in *Pterostichus vulgaris*, Linn., are as 0·017:0·01:0·004, and in *Niptus hololeucus*, Cam., as 0·004:0·0025:0·000. The last two species do not fly at all, as the hind wings are either so small that they cannot support the body or entirely wanting.

As the wings are already indicated in the larva, I was inclined to think that, in one or other of the species entirely destitute of wings, traces of these organs would occur, at least in the larval or the pupal stage. For four years my labours were in vain, and it is only quite recently that I succeeded in demonstrating the rudimentary hind wings in the larvæ and pupæ of *Niptus hololeucus*, Cam., in which both sexes are apterous, i. e. destitute of hind wings.

This pretty little beetle has come to us from Asia Minor, and occurs frequently in Berlin in houses from July to September. It likes to conceal itself among linen and woollen stuffs. M. Kläger, who was kind enough to furnish me with material, found the perfect beetle every year in a linen-press among the accumulated linen. M. Wachtler, a merchant here, to whom I am also indebted for a great number of the animals, found them in bales of stuffs. He thinks that they seek these hiding-places, not to lay their eggs there, but to protect themselves from the cold; he did not observe even the smallest quantity of frass upon the stuffs.

After several unsuccessful attempts, I succeeded in rearing the beetles in bran. For this purpose I placed the animals, in the autumn, in a vessel filled with bran. Here they deposited their eggs; and at the end of March the larvæ were full-grown. They are 0·006 metre long, white with a few scattered brown hairs, and have the form of the grub of the cockchafer.

The rudiments of the fore wings appear in the half-grown larva, on the two sides of the mesothorax, as crescentiform

thickenings of the hypodermis ; in the full-grown larva the wing appears as a crescentiform lobe standing free from the hypodermis and between that and the chitinous membrane. The wing-rudiments grow directly outwards, and do not lie, as in the *Lepidoptera* and *Phryganeidæ*, in sac-like diverticula. As these wing-lobes are placed under the chitinous membrane until the passage to the pupa state, it follows that, after the appearance of the wing during the larval existence, no ecdysis takes place. Of the hind wings no trace is to be seen ; the hypodermis on the sides of the third thoracic segment is just as thin as on the other parts of the body. It is only when the animal spins up* that a semicircular thickening of the hypodermis is formed on each side of the third thoracic segment. As always in the formation of the imaginal disks, a tracheal and a nervous branchlet run to the spot, and probably furnish the incitement to the multiplication and accumulation of the hypodermal cells. Some time after the spinning-up we find the fore wing as a long flat lobe lying beneath the old chitinous membrane of the larva, and reaching down nearly to the legs. It is widened in its basal part, and pointed at the opposite end. At this time a halfmoon-shaped flat lobe has grown out of the thickening on the sides of the third thoracic segment, agreeing exactly in structure and form with the earlier formed halfmoon-shaped fore wing of the full-grown larva.

The old chitinous skin of the larva is thrown off ; and the wings, like the other members, come freely into view after a new chitinous membrane has been secreted over them as over the whole body.

In the pupa the fore wing is of considerable length, while the hind wing lies on the side of the third thoracic segment in the form of a very minute freely projecting scale. In the fully developed beetle I could detect no trace of the hind wing ; and should any thing of the kind be discoverable, it will be at the utmost a minute chitinous wart, for the production of which an imaginal disk with tracheæ and nerves can never have been necessary.

While the fore wing, therefore, already occurs in the half-grown larva, the rudiment of the hind wing only shows itself much later, when the animal is already on the point of terminating the larval stage. That these rudiments of hind wings, occurring only in the last larval stage of all and in the pupal

* For this purpose a thread is drawn out of a gland situated in the neighbourhood of the anus, and with this the animal fastens together small particles of bran.

stage, have no purpose to serve is perfectly clear. We have therefore to do with an organ which either will at some time arrive at full development and function, and is consequently advancing, or which was at an early period well developed and in use as an organ of flight, and has consequently retrograded.

That it is not an advancing organ, but one in course of disappearance, is shown most decidedly by the circumstance that this, like all retrogressive organs, does not, like those in full function, increase with the development of the individual, but, on the contrary, diminishes.

We are therefore justified in assuming that *Niptus holo-leucus* once bore well-developed hind wings, and that these gradually became aborted in consequence of disuse, until they were finally thrown back into the young stages, and some day will disappear even from these stages. In other wingless beetles this period may have already occurred.

While in other cases the hind wings make their appearance nearly at the same time as the fore wings, we have seen that the aborted hind wings in *Niptus* originate much later than the equivalent organs which attain development, namely the fore wings. This circumstance seems to show that rudimentary organs are not only thrown back to the younger stages, but that, in many cases also, the period of their appearance is much later than with the equivalent well-developed organs. They are consequently, if I may so express myself, straitened on two sides. I do not know whether other rudimentary organs, such, for example, as the upper incisors of the Ruminants, which never break through, make their appearance much later than the well-developed lower ones.

This abortion of an organ brings after it other transformations of the body. Without the hind wings the beetles cannot fly. It is therefore not necessary for them to be able to spread out the elytra, the latter rather remain permanently lying upon the back. What is the consequence? The two elytra grow together to form a firm dorsal shield, such as we find in nearly all beetles which are entirely destitute of hind wings. At the same time the elytra become convex and bend round at the sides, so that they embrace the abdomen. In consequence of the disappearance of the wing-muscles, the thorax becomes altered. The body acquires quite a different form; new forms are produced which we call species.

XV.—*On the Systematic Relations of the Carnivora Fissipedia.* By E. D. COPE*.

THIS order embraces the clawed Mammalia with transverse glenoid cavity of the squamosal bone, confluent scaphoid and lunar bones of the carpus, and well-developed cerebral hemispheres. It is well distinguished from all others at present known; but such definition is likely to be invalidated by future discovery. Some of the Insectivora possess a united scapholunar bone; but the reduction of the cerebral hemispheres of such forms distinguishes them. The presence of the crucial fissure of the hemispheres is present under various modifications in all Carnivora, while the parieto-occipital and calcarine fissures are absent.

The many types of existing Carnivora fall into natural groups which are of the grade termed family in zoology. But the distinction of these from each other is not easily accomplished, nor is it easy to express their relations in a satisfactory manner. The primary suborders of Pinnipedia and Fissipedia are easily defined. Various characters have been considered in ascertaining the taxonomy of the more numerous Fissiped division. The characters of the teeth, especially the sectorials, are important, as is also the number of the digits. Turner† has added important characters derived from the foramina at the base of the skull and the otic bulla, which Flower‡ has extended. Garrod§ has pointed out the significance of the number of convolutions of the middle and posterior part of the hemispheres. I have added some characters derived from the foramina of the posterior and lateral walls of the skull||. Mr. Turner also defines the families by the form and relations of the paroccipital process.

In studying the extinct Carnivora of the Tertiary period it has become necessary to examine into the above definitions in order to determine the affinities of the numerous genera which have been discovered. To take them up in order, I begin with the foramina at the base of the skull. The result of my study of these has been that their importance was not overrated by Mr. Turner, and that the divisions of secondary rank indicated by them are well founded. Secondly, as to the

* From the 'Proceedings of the American Philosophical Society,' vol. xx. no. 112, p. 471, having been read before the American Philosophical Society on October 20, 1882.

† Proc. Zool. Soc. Lond. 1848, p. 63.

‡ Loc. cit. 1869, p. 5.

|| Proc. Amer. Phil. Soc. 1880.

§ Loc. cit. 1878, p. 377.

form and structure of the auditory bulla. Although the degree and form of inflation are characteristic of various groups of *Carnivora*, they cannot be used in a systematic sense, because, like all characters of proportion merely, there is no way of expressing them in a tangible form. For if the forms in question pass into each other, the gradations are *insensible*, and not sensible, as is the case with an organ composed of distinct parts. The same objection does not apply so much to the arrangement of the septa of the bulla. The septum is absent in the *Arctoidea* of Flower (*Ursidæ* of Turner), small in the *Cynoidea*, Flower (*Canidæ*, Turner), and generally large in the *Æluroidæ*, Flower (*Felidæ*, Turner). But here occurs the serious discrepancy that in the *Hyænidæ*, otherwise so nearly allied to the *Felidæ*, the septum of the bulla is wanting. Nevertheless the serial arrangement of the order indicated by Flower, viz. commencing with the *Arctoidea*, following with the *Cynoidea*, and ending with the *Æluroidæ*, is generally sustained by the structure of the auditory bulla and by the characters of the feet and dentition, as well as of the cranial foramina. Turner's arrangement in the order, *Ursidæ*, *Felidæ*, and *Canidæ*, is not sustained by his own characters; and its only support is derived from Flower's observations on the external or sylvian convolution of the hemisphere of the brain*. There are three simple longitudinal convolutions in the raccoons; in the civets and cats the inferior convolution is fissured at the extremities, while in the dogs it is entirely divided, so that there are four longitudinal convolutions between the sylvian and median fissures.

An important set of characters hitherto overlooked confirms Flower's order. I refer to those derived from the turbinal bones. In the ursine and canine forms generally the maxilloturbinal is largely developed, and excludes the two ethmoturbinals from the anterior narial opening. In the Feline group, as arranged by Turner, the inferior ethmoturbinal is developed at the expense of the maxilloturbinal, and occupies a part of the anterior narial opening. These modifications are not, so far as my experience has gone, subject to the exceptions seen in the development of the otic septa and molar teeth, while they coincide with their indications. The seals possess the character of the inferior group, or *Ursidæ*, in a high degree.

The characters derived from the paroccipital process are of limited application, as the study of the extinct forms shows.

I would then divide the fissiped *Carnivora* into two tribes, as follows:—

* Proc. Zool. Soc. Lond. 1869, p. 482.

External nostril occupied by the complex maxilloturbinal bone; ethmoturbinals confined to the posterior part of the nasal fossa; the inferior ethmoturbinal of reduced size *HYPOMYCTERI*.
 External nostril occupied by the inferior ethmoturbinal and the reduced maxilloturbinal *EPIMYCTERI*.

While no doubt transitional forms will be discovered, the types at present known fall very distinctly into one or the other of these divisions. The characters are readily perceived on looking into the nares of well-cleaned specimens. The Hypomycteri stand next to the Pinnipedia, since the maxilloturbinal bone has the same anterior development in that group.

In searching for definitions of the families it is necessary to be precise as to the definition of terms. The meaning of the word sectorial is in this connexion important, since there are so many transitional forms between the sectorial and tubercular tooth. A sectorial tooth then of the upper jaw is one which has at least two external tubercles, which are the homologues of the median and posterior lobes of the sectorial of the cat. By the flattening and emargination of their continuous edges the sectorial blade is formed. One or two interior and an anterior lobe may or may not exist. In the genera of the Procyonidæ, except in *Bassaris*, the two external tubercles do not form a blade. The inferior sectorial tooth differs from the tubercular only in having an anterior lobe or cusp, which belongs primitively to the interior side. The inferior sectorial teeth with large heels, as in Viverridæ and Canidæ, I have called tubercular sectorials. The sectorial blade is formed by the union and emargination of the edges of the anterior and the principal external cusp. This blade is not well developed in the genus *Cynogale*, and still less in the Procyonidæ and Ursidæ. The families are then defined as follows:—

HYPOMYCTERI.

- I. No sectorial teeth in either jaw.
 Toes 5 . 5 *Cercoleptidæ*.
 II. Sectorial teeth in both jaws.
 a. Toes 5 . 5.
 β. No alisphenoid canal.
 True molars $\frac{2}{3}$ *Procyonidæ*.
 " " $\frac{2}{3}$ *Mustelidæ*.
 ββ. An alisphenoid canal.
 Molars quadrate, $\frac{2}{3}$ *Æluridæ*.
 Molars longitudinal, $\frac{2}{3}$ *Ursidæ*.
 aa. Toes 5 . 4 or 4 . 4
 Sectorials well developed, an alisphenoid canal *Canidæ*.

EPIMYCTERI.

- I. Molars haplodont.
 Toes 5 . 4; no alisphenoid canal *Protelidæ*.
- II. Molars bunodont, no sectorials.
 Toes 5 . 5; an alisphenoid canal *Arctictidæ*.
- III. Molars bunodont, with sectorials.
 α. Otic bulla with septum.
 β. Alisphenoid canal and postglenoid foramen present.
 γ. True molars well developed.
 Toes 5 . 5 *Viverridæ*.
 Toes 5 . 4 *Cynictidæ*.
 Toes 4 . 4 *Suricacidæ*.
 γγ. True molars much reduced.
 Toes 5 . 5 *Cryptoproctidæ*.
 Toes 5 . 4 *Nimravidæ*.
 ββ. No alisphenoid canal; postglenoid foramen rudimental or wanting.
 Toes 5 . 4 *Felidæ*.
 αα. Otic bulla without septum.
 No alisphenoid canal nor postglenoid foramen: toes
 4 . 4 *Hyænidæ*.

The genera of these families are the following :—

- CERCOLEPTIDÆ: *Cercoleptes*. Neotropical.
 PROCYONIDÆ: *Procyon**, *Bassaricyon*, *Bassaris*. Ne-
 arctic and Neotropical.
 MUSTELIDÆ: *Melinae* (two tubercles of internal side of
 superior sectorial)—*Taxidea*, *Meles*; *Mustelinee* (one
 internal tubercle of superior sectorials)—*Enhydris*,
Pteronura, *Lutra*, *Aonyx*, *Barangia*, *Helictis*, *Zorilla*,
Mephitis, *Conepatus*, *Mellivora*, *Gulo*, *Galictis*, *Puto-*
rius, *Mustela*.
 ÆLURIDÆ: *Ælurus*, *Æluropoda*, ? *Hyænarcos*.
 URSIDÆ: *Helarctos*, *Arctotherium*, *Ursus*, *Melursus*.
 CANIDÆ: *Megalotis*†, *Amphicyon*, *Thous*, *Palæocyon*,
Temnocyon, *Galecynus*, *Canis*, *Vulpes*, *Enhydrocyon*,
Hyenocyon, *Brachycyon*, *Tomarctus*, *Speothus*, *Syna-*
godus, *Dysodus*, *Oligobunis*, *Icticyon*, *Lycaon*.
 PROTELIDÆ: *Proteles*. Ethiopian.
 ARCTICTIDÆ: *Arctictis*. Indian.
 VIVERRIDÆ: *Cynogale*, *Arctogale*, *Paguma*, *Paradox-*
urus, *Nandinia*, *Hemigale*, *Galidia*, *Prionodon*, *Ge-*
netta, *Viverricula*, *Viverra*, *Galedictis*, *Herpestes*,

* Including *Nasua*, which is not distinct.

† This genus cannot be made the type of a family, as is done by Dr. Gray.

Athylax, *Calogale*, *Ichneumia*, *Bdeogale*, *Urva*,
Tæniogale, *Onychogale*, *Helogale*, *Rhinogale*, *Mungos*,
Crossarchus, *Eupleres*.

CYNICTIDÆ: *Cynictis*, ? *Ictitherium*.

SURICATIDÆ: *Suricata*. Ethiopia.

CRYPTOPROCTIDÆ: *Procelurus*, *Cryptoprocta*.

NIMRAVIDÆ: *Archælorus*, *Nimravus*, *Ælurogale*, *Di-*
nictis, *Pogonodon*, *Hoplophoneus*.

FELIDÆ: *Machærodontinae*—*Machærodus*, *Smilodon*;
Felinae—*Plethælorus* (g. n.)*, *Catolynx*, *Felis*, *Ne-*
felis, *Uncia*†, *Lynx*, *Cynælorus*.

HYÆNIDÆ: *Hyænictis*, *Hyæna*, *Crocuta*.

XVI.—Notes on the Mollusca in the Great International Fisheries Exhibition, London, 1883, with the Description of a new Species of *Pleurotoma*. By J. GWYN JEFFREYS, LL.D., F.R.S.

THE interest taken by the public in this great world's show continues unabated. But it does not seem to have attracted the attention of conchologists; although the contrary might have been expected, seeing that many of our rarest shells have been procured from the stomachs of fishes and even been caught by the bait intended for the latter.

Apart from the economic or food-supplying object of the Exhibition, there is not much of science or natural history in the department of Mollusca. Oysters, of course, play a considerable and aristocratic part in it, and are amply displayed. Not so with mussels, cockles, whelks, periwinkles, and other "small deer," which are so relished by the poorer classes in the dog days.

The Mollusca are well known to constitute, together with Crustacea, Annelids, and various other invertebrate animals, the principal food of most fishes. I have myself seen between thirty and forty specimens of the common whelk (*Buccinum undatum*) taken from the stomach of a single cod. Ørsted says, in his interesting treatise 'De regionibus marinis,'

* Type *Felis planiceps*, Vig. Horsf. Char. Second (first) superior pre-molar two-rooted; orbit closed behind; pupil round.

† Mr. Wortman has called my attention to a character of this genus which confirms its separation from *Felis*, as I proposed in 1879. The maxilloturbinal bone is less complex in the genus *Uncia* than in *Felis*, consistently with a less nocturnal habit and less necessity for acute smell.

that great numbers of *B. undatum* and *Fusus antiquus* are collected in the Cattegat for fish-bait, by putting a dead cod into a wicker basket and letting it down on a muddy bottom; it is soon taken up half filled with whelks. The same method is adopted for their capture on the English and Irish coasts. This is a good illustration of the *lex talionis*. The Romans must have prized the whelk as a foreign luxury during their occupation of this country. Shells of *B. undatum*, mixed with those of the oyster, were found among the ruins of the Roman station at Richborough. Whelks of two kinds ("white" and "almond") are in great request and sold by millions in the lower fishmarket at Billingsgate.

The Exhibition presents some absurd incongruities. Allowing every latitude to the interpretation of the word "fisheries," it appears rather strange to include among their products a large assortment of copper-ore and other minerals from Newfoundland, and cases of Lepidoptera from the Entomological Society of Canada; nor can we quite see the connection between fishes and Algæ or seaweeds, which are so profusely exposed to view in the courts of the United States of America, Italy, Norway, Russia, and other foreign countries.

However, instead of indulging in useless criticism, I will proceed to make some remarks on the Mollusca in the Exhibition, considered in a natural-history point of view; and I will take the courts according to their order in the catalogue. In doing this I shall be glad to express my obligation to the Colonial and Foreign Commissioners for their extremely courteous attention and for allowing me to examine all the Mollusca in their departments.

GREAT BRITAIN.

Nothing worthy of notice.

BAHAMAS.

A collection of small and common shells without names.

BRITISH COLUMBIA.

A magnificent specimen (in spirit) of *Cryptochiton Stelleri*, Middendorff. The only other habitats previously known for this singular mollusk were the Siberian coast and Sitka.

CANADA.

This is not in the official Catalogue, except to give the names of the Commissioners. The court contains a well-

arranged and interesting collection of eatable Mollusca. The word "eatable" puts me in mind of my old friend Edward Forbes. When he went to Shetland he dredged in Lerwick Bay the large and now well-known Holothuroid *Cucumaria frondosa*, which resembles a pudding. He called it a "comestible;" and his boatman Peter, who was quite a character, afterwards took me with my dredge to the same spot, and was very proud of telling me the right name, which he had improved into "combustible!"

NEWFOUNDLAND.

Also omitted in the Catalogue. Mr. T. A. Verkrüzen supplied a case of marine shells, arranged with his usual care and neatness. *Buccinum undatum*, *grœnlandicum*, *tenuë*, and *Totteni* are represented by several varieties under not a few specific names.

UNITED STATES OF AMERICA.

An extensive and admirably displayed collection of the shells of *Ostrea virginica* or the American oyster. This species may always be known by the purplish or dark violet colour of the muscular scar. Its variability in shape and size is not less than that of its European congener, *O. edulis*. In this section is to be seen an excellent model of the gigantic squid (*Architeuthis Harveyi*?) of Prof. Verrill; but unfortunately its extraordinary length has been somewhat curtailed by the clumsiness of a carpenter who set it up and fastened the arms or tentacles in such a manner that justice has not been done to the model. Here are also shown a model of the new exploring-ship or Fish-commissioners' steamer 'Albatross,' as well as sundry apparatus, such as improved kinds of trawl, dredge, accumulator, Sligsbee's net for intermediate depths, and many other ingenious contrivances.

FRANCE.

Oysters only.

HAITI.

Common tropical shells without names.

ITALY.

A miscellaneous lot of small unnamed shells from Naples, mixed with exotic *Neritæ*. Attached to the native corals, of which there is a large assortment, may be observed valves of *Ostrea cochlear*, showing how they had become altered in

shape by the conditions of their peculiar habitat. I more than suspect that this so-called species of oyster is merely a variety of *O. edulis*, which was necessarily moulded on the branching coral, and therefore grew in the form of a bowl or cup. A large tropical *Bulimus* and a specimen of *Helix pomatia* are perched on a madrepora, as if in their usual association and position.

NETHERLANDS.

A poor set-out of native shells not properly named, and a few shells from Madagascar.

NORWAY.

Mollusca from Tromsø, 69° 40' N. lat., and therefore far within the arctic circle. This is a good collection of fine specimens, but of a few species only, including *Fusus gracilis*, var. *glaber*, *F. islandicus*, *F. Sarsi*, *Buccinum undatum* and its varieties *parvulum* and *fragile*, *B. groenlandicum* (if not also a variety of the last) and its variety *finmarchianum*.

SPAIN.

An unsatisfactory exhibit; some specimens are wrongly named, e. g. "*Teredo navalis*" instead of *T. norvegica*.

SWEDEN.

Dr. Malm's Mollusca from the Gothenburg Museum. An old collection, and some specimens wrongly named, e. g. *Mya Binghami*, var. *elongata*, which is placed with *Saxicava rugosa* as the young of that species. There are also a few shells from Bohuslän, which were contributed by Mr. Oscar Dickson, including *Stilifer Turtoni* of Broderip and Sowerby, *Pleurophyllidia Loveni* of Bergh, and *Loligo Forbesi* of Steenstrup. But the most important collection of Mollusca in the Exhibition was furnished by Prof. Nordenskjöld, having been dredged in the icy or Siberian Sea during his celebrated voyage in the 'Vega.' All of these are truly arctic species; and it may be desirable to mention a few of them with the recorded depths:—CONCHIFERA: *Amussium Hoskynsi*, Forbes, 75 fathoms, very large; *Astarte fabula*, Reeve, = *A. Warhami*, Hancock, 10 fathoms. GASTROPODA:—*Trichotropis Krøyeri*, Philippi, 55 fathoms; *T. crinifera*, Leche, 55 fathoms; *Purpura Freycineti*, Middendorff, 0–1 fathom; *Buccinum Totteni*, Stimpson, var., = *B. terræ-novæ*, Mörch, 55 fathoms; *Pleurotoma* sp. n., 55 fathoms. As Dr. Leche of Stockholm writes me word that he intends to describe the Conchifera only from

the 'Vega' expedition, I venture to propose the name *in-signis* for this grand species. I believe it is larger than any other known *Pleurotoma*, recent or fossil. It is about three inches long and an inch broad. Colour creamy under the coating of a Hydrozoon which infests all the specimens. Whorls 7-8, convex; apex turreted. Sculpture consisting of numerous spiral striæ or slight ridges, besides a rather sharp and prominent keel in the middle of each whorl. Suture distinct. Fissure or slit broad but not very deep, placed about halfway between the suture and the median keel. The infrasutural or fissural space is marked (as in other species of *Pleurotoma*) with flexuous lines of growth. Mouth irregularly oblong. Many of the specimens have a short sinus in the outer lip at the commencement of the canal, which latter is of moderate length and nearly equally wide throughout. Inner lip smooth, and polished by the continual attrition of the foot. Operculum none. There were ten living specimens in this collection. CEPHALOPODA: *Heteroteuthis tenera*, Verrill, 15 fathoms.

After all has been said we cannot be much surprised to find that this Exhibition is not a museum of natural history. The masses are as yet far from being educated in such matters, and they would simply regard a properly arranged collection of specimens which are not useful to man in the most cursory and incurious manner and without the slightest scientific interest. Perhaps it may be different in the next century.

XVII.—*On two Freshwater Sponges* (*Spongilla nitens*, Carter, and *S. Böhmii*, sp. n.) collected by Dr. R. Böhm in the River Ugalla near Lake Tanganyika. By M. HILGEN-DORF*.

THE fifteen dry specimens, of bright greyish-brown colour, from 5 to 15 centim. [2 to 6 inches] in diameter, and of broadly conical, hemispherical, or horizontally expanded form, closely resemble one another. Their surface is covered with short slender prominences, each separated from the neighbouring ones by interspaces larger than its own diameter and continued radially through the interior substance of the sponge. In the principal portion a framework goes from one radial cord to another; and in the meshes thus formed numerous

* Translated from a separate impression from the 'Sitzungsbericht der Gesellschaft naturforschender Freunde,' May 22, 1883, communicated by H. J. Carter, F.R.S. &c.

gemmae [statoblasts] are imbedded, but without penetrating the peripheral part. The trabeculae of the framework lie loose in the centre.

The *skeleton-spicules* have rounded ends and are moderately curved; very few of them (perhaps one among 200 ordinary spicules) are seen with pointed ends, but always with cylindrical middle part: these are of equal length with, but in diameter only half as large as the former. From 4 to 6 spicules combine to form the thickness of a trabecula. The diameter of the meshes may be twice that of a gemmula.

The one-pored gemmae possess a considerably thickened crust, which (enumerating from the centre outwards) consists of a layer of chitine, a stratum of tangential spicules, a mass of parenchyma, and a second (outer) stratum of spicules. These spicules are half as long as those of the skeleton; and each forms a slender double cone armed with scattered, short, pointed spines, and is mostly pointed at its ends. They are present only in small number, about 30 to each hemisphere of a layer, making a total of 120 in a gemmula. The parenchyma consists of delicate-walled vesicles, polyhedric by compression, arranged in radiating series of about ten each. In the radial direction they are flattened, so that their height may amount to half their breadth.

Measurements.—

	millim.
Diameter of the largest specimen	130
Height	50
Length of the outgrowths upon the surface	6
Thickness	1
	micromillim.
Length of the skeleton-spicules	336
Thickness	28
Diameter of the gemmulae	308
Thickness of the entire crust	56
Tangential diameter of the parenchyma cells	14
Radial diameter	5.6
Length of the gemmula-spicules	154
Thickness	8.4

These data accord, so far as a comparison from the description is possible, with the *Spongilla nitens* of Carter (Ann. & Mag. Nat. Hist. 1881, vii. p. 89); only I do not find there any statement about the flattening of the polyhedric cells, upon which, however, much weight can hardly be laid. Unfortunately the locality of that species is not known; but from their unmistakable similarity to the present form, Carter's specimens may likewise have come from Africa, and not from South America as he supposes.

Until now, the occurrence of a freshwater sponge from Africa had never been proved, while recently North and South America and Asia (Borneo, India, Lake Baikal, Japan) had furnished numerous species; so that Dr. Böhm's find appears zoogeographically not unimportant. (Zool. Mus. Protozoa 810.)

On looking more closely, however, my attention having been arrested by the appearance of a strange spicule in a prepared specimen, I found a new and hitherto quite unknown species of *Spongilla* on almost every individual of *S. nitens*. It coats the underside of the much more massive *S. nitens* as an inconspicuous crust of only 1 millim. thickness, consisting of a very fine-meshed delicate framework. The magnificent gemmulæ are grouped in a single layer of from 8 to 12 within the skeleton, but at the same time much projecting from it; in several examples they are entirely wanting; and where they are present there are always very few of them.

A delicate homogeneous lamella sharply divides the two species.

The *skeleton-spicules* are of the same form as in *S. nitens*, but, instead of being smooth, are studded with roundish flattened tubercles which at the ends approach considerably closer together; they are scarcely half as long as in that species. They are often accompanied by a four-times smaller amphidiscoid form. The shaft of these siliceous bodies is gently curved, and bears at some distance from the centre a small spherical elevation; from a similar one at each end of the shaft proceed five short, pointed, recurved prongs, exactly as in a whorl. These double whorls lie close to the large spicules, and form with them the network, the threads of which consist mostly of only one spicule in thickness. The width of the meshes may amount to 200 millimetres.

The *gemmulæ* have not the layer of parenchyma; the spicules lie tangentially and in only a single layer; but they are densely crowded and at the same time minute; so that their number is very considerable and far exceeds a thousand in one gemmula. There is perhaps a larger portion of the surface covered by the spicules than left free from them, in which they moreover frequently cross one another. Each spicule is moderately curved, cylindrical, with only the last eighth or tenth part tapering to a point; the surface bears a moderate number of short acute spines, of which from 8 to 10 may occupy the length, and about 50 the entire spicule.

Measurements.—

Skeleton-spicules—	micromillim.
Length	140
Thickness	14
Diameter of tubercles	1.5
Double whorls, length	33.6
Length of the teeth (from the centre) ..	5.6
Thickness of the axis	2.3
Gemmula-spicules—	
Length	56
Thickness	5.6

As, from the absence of amphidisks or rudimentary amphidisks, the genera *Meyenia*, *Tubella*, and *Parmula* are excluded, and all the species of *Spongilla* in the restricted sense possess pointed skeleton-spicules, excepting only *S. nitens* (cf. Carter's synopsis, *l. c.*), our second form must without doubt be regarded as a new species, which, in honour of its discoverer, shall be named *Spongilla* (s. s.) *Böhmii* (Zool. Museum, Protozoa no. 811).

PROCEEDINGS OF LEARNED SOCIETIES.

DUBLIN MICROSCOPICAL CLUB.

May 18, 1882.

Nephrocytium Agardhianum, Näg., and *Zoospores*.—Mr. Archer showed examples of the two minute Algæ, *Nephrocytium Agardhianum*, *majus* et *minus*, Nägeli, and remarked that he thought these two forms very distinct indeed, dwelling at the same time on their resemblances and distinctions as regards the genus *Oocystis*, Näg. But he was on the present occasion more particularly anxious to draw attention to examples of the former, which he would be disposed to designate only *Nephrocytium Agardhianum* (and the smaller *Nephrocytium minus*), inasmuch as it (*N. Agardhianum* proper) showed a zoospore condition. An example was now under the microscope, in which the four elliptic, necessarily comparatively large, biciliated zoospores were still contained in the parent cyst, within which they performed a lazy side-to-side movement. On their escape, however, into the surrounding water their movements become greatly accelerated, and they dash about with great force and, as it were, recklessness, hither and thither. Considerable differences of size were apparent, some being nearly twice as large as others. Mr. Archer would suggest that this might be due to whether an average example became divided into four or eight subdivisions ;

in the latter case evidently the individual zoospores would only be approximately about one half the size. It is true, however, that the still (that is, the ordinary vegetative), characteristic examples do not usually present any very great differences in size, but maintain generally characteristic dimensions.

Protococcus pluvialis, to show Nucleus.—Dr. M'Nab showed specimens of the ciliated state of *Protococcus* (*Ohlmydococcus*) *pluvialis*, treated with osmic acid and carmine. The nucleus was most clearly seen in each free cell, and also in others, which had divided or were then undergoing division into four or eight new cells.

Laticiferous Cells of Euphorbia.—Dr. M'Nab exhibited a freshly prepared specimen of the laticiferous cells of *Euphorbia proceræ*; a portion of the stem was boiled in dilute caustic potash solution and then teased out with needles.

Polyedrium gigas, Wittrock, a rare Form, exhibited.—Mr. Archer further showed *Polyedrium gigas*, Wittrock, the second time he had taken this fine and very distinct form, so large, so bright, so green, and so unlike the other rather dull-coloured forms referable to Nägeli's genus. These specimens were from the same county as previously, though not the same locality in Westmeath.

June 15, 1882.

Ascidiozooids of a Pyrosoma.—Prof. A. C. Haddon exhibited a preparation from the Naples Zoological Station, showing four ascidiozooids budding off from a cyathozoid, thus forming the foundation of a *Pyrosoma*-colony. He also presented a second preparation, being the initial individual of a *Botryllus*-group in a stage between the larva and the adult.

Stenella, n. s., exhibited.—Prof. E. Perceval Wright exhibited a mounted specimen from the 'Challenger' collection of a new species of *Stenella*, near to but abundantly distinct from *S. imbricata*, Johnson; this seems to have been met with very frequently during the cruise of the 'Challenger.'

Cosmarium melanosporum, n. s., with Zygosporæ.—Mr. Archer showed the conjugated state in very considerable quantity of the little smooth *Cosmarium*, with round, very darkly tinted zygosporæ, from which circumstance Mr. Roy and he had agreed to call the form *Cosmarium melanosporum*. This species conjugates pretty frequently and always freely; so that, when met with, a large gathering may thus sometimes be made.

Elongate unicellular Alga seemingly related to the so-called Cosmarium obtusum, Bréb.—Mr. Archer drew attention to one of those unicellular, elongate, more or less curved Algæ, believed to be generically associated with the so-called *Olosterium obtusum*, Bréb., but not properly referred to *Olosterium*. The present form is com-

paratively stout, broad for its length, scarcely tapering, evenly curved ("boomerang"-shaped), ends broadly rounded; contents dense, consisting of scattered rounded granules. Perhaps the most curious point in the present instance was that, mounted only some forty-eight hours in acetate of potash, the green contents had to all appearance become dissolved, and only the empty hyaline otherwise unaltered cell-walls were now to be seen of some half dozen examples that were on the slide.

October 19, 1882.

Quasi-Fungal Growth in Shell of Limax.—Prof. Mackintosh called attention to an apparently fungal growth in a shell of *Limax cinereus*, mounted last December. He had noticed the growth a couple of days after mounting; and it had continued in the same state since. It might be in the medium (alcoholic glycerine); but it seemed to him to be in the periostracum. If this were so, it would be similar to, but less easily accounted for than, the supposed hyphal growths in the shells of branchiate Gasteropods.

Spicules of new Species of Alcyonaria from 'Challenger' Collection.—Dr. E. Perceval Wright exhibited some mounted spicules of two new species of *Alcyonaria* belonging to the genus *Prinnoella*, as well as drawings of the polyp-colony. These formed part of the collection made by the 'Challenger' expedition, of which full descriptions are to appear in the forthcoming Report.

Cystidia from Gill of Gomphidius glutinosus.—Mr. Greenwood Pim exhibited a section of the gill of *Gomphidius glutinosus*, which showed the so-called cystidia developed to an extent very unusual amongst the Agaricini. These bodies, which in Agarics in general, except the Coprinarii, are scarcely discernible, are looked upon by Mr. W. G. Smith as being the male organ in this group. In the specimen shown there was nothing to confirm this view, the organ consisting of large cells resembling hairs, filled with a granular protoplasm and projecting a long way from the hymenial surface. It is probable that these somewhat anomalous bodies are analogous to the paraphyses met with in the Pezizas. Nothing resembling the antheridia described by Mr. Smith was discernible in Mr. Pim's specimen, in which the basidiospores were abundant and well developed.

Motile state of the "80" Organism (Club Minutes, January 1871).—Mr. Archer showed the production he had before drawn attention to under the provisional designation of the "80" organism; and he would first say that quite as little as then was he able to arrive at a conclusion as to the nature or affinity of this puzzling and by no means attractive-looking organism. But he drew attention to it again in order to exhibit once more its puzzling and astonishing motile condition—that is to say, to show the broken-up

contents, each fraction (zoospore?) made up of one, or two, or three of the granules (often two larger and one of the more minute, or one large with two or three more minute), arranged in a tolerably straight file and enclosed in a proper envelope, and moving about in sweeps and curves or more or less straight directions, revolving the while on the longitudinal axis. Those who are adepts at using $\frac{1}{25}''$ or $\frac{1}{50}''$ objectives might possibly discern flagella similar to those of *Bacteria*; but nothing of the kind could be seen with ordinary powers. These little moving bodies ere long come to rest, and even though still small, not a half or a quarter of the full dimensions, become divided and reproduce the "80" characteristics.

Section of Velum and Foot of Veliger larva of Purpura lapillus.—Professor A. C. Haddon exhibited a transverse section through the velum and foot of a veliger larva of *Purpura lapillus*, showing the development of the nervous system in four thickenings of the epiblast, this being the first time that the nervous system has been proved to have an epiblastic origin in the Prosobranchs.

Sections of Hair-follicles stained.—Dr. J. F. Knott showed sections of hair-follicles of human scalp perpendicular to long axis of hairs, stained with picro-carmin and aniline violet, which latter tinges the outer (Henle's) layer of the inner root-sheath. Huxley's layer staining with picro-carmin as well as the outer root-sheath, the various layers of the complex wall of the hair-follicles are extremely well differentiated. Some of the specimens show with plainness the processes sent by the cells of Henle's layer into the intercellular fenestræ of the layer of Henle. This particular arrangement, which has been lately so graphically described by Professor Ranvier, formed the chief interest of the specimen. It accounts for the closeness of adhesion between the layers long ago observed, but which had previously remained unexplained.

November 17, 1882.

Section of Plumule of Germinating Seedling Opuntia.—Dr. M^cNab exhibited sections of a plumule of a germinating seedling *Opuntia*. The punctum vegetationis was distinctly shown, with the leaves originating in the normal manner, the older ones having contracted axillary shoots bearing spines and hairs. The leaves were of very simple structure and outline, and possessed a single central fibro-vascular bundle.

Another nondescript problematic Production.—Mr. Archer showed an example of a puzzling structure now and again met with in deep pools and amongst débris of various sorts. This is somewhat large, of plumply ovate figure, of brownish colour, opaque, covered by prominent scale-like or leaf-like seemingly imbricated projecting prominences—these, if he judged aright, running in spiral lines, the contents coarsely granular, thus the whole resembling in figure and

calling to mind the involucre, with its projecting leaflets, of certain Composites, say such as that of *Centaurea nigra*. This occurs isolated, single examples turning up now and again. The question is, what can it be? It has never shown any sign of life or change of condition.

A Form of Aspergillus.—Mr. Greenwood Pim showed a peculiar black form of *Aspergillus* from the interior of a fig, which it had completely metamorphosed. It was considerably smaller in all its parts than *Aspergillus glaucus*; and its intense brownish-black colour would seem to point to its being at least a distinct variety.

December 15, 1882.

Spores of Tuber aestivum.—Mr. Pim showed sections of the (so-called) common Truffle (*Tuber aestivum*), from Farmleigh Gardens, Castleknock, co. Dublin, where it grows in considerable abundance and is used for culinary purposes. The peculiar alveolate spores distinguishing it from *T. brunale*, the other species used as an esculent, were well marked.

Structure of Stem of Urvillea.—Dr. McNab exhibited sections of the stem of *Urvillea ferruginea*, a Brazilian plant belonging to the natural family Sapindaceæ. The stem was triangular, with a row of hairs at each angle. The stem contained a ring of united fibro-vascular bundles in the centre with a pith, the bast showing the bast-vessels with great clearness, while the bast-fibres were wanting. Three double bundles were developed, one at each angle of the stem; and a ring of sclerenchyma surrounded the stem a short distance below the epidermis. Collenchyma existed in six patches, one at each angle and one in the middle of each face.

Nerve-endings in Frog's Muscle.—Dr. Knott showed preparations presenting examples of nerve-endings in muscle of frog.

Zygospore of Cosmarium cucurbita (most probably) shown.—Mr. Archer exhibited what appeared to be the zygospore of the common *Cosmarium cucurbita*, rotund and smooth, the parent semi-cells attached by their oscula to the spore; he spoke of this appearing to be the zygospore of the species mentioned, as one could not feel absolutely certain that it was truly so, a number of unconjugated examples occurring in the gathering; but if not so, it would be difficult to suppose to what other species the example could appertain. The doubt arose from the semi-cells appearing to be slightly distorted, that is somewhat dilated at the ends, thus losing the character of outline appertaining to this inornate and very common species; but frequent as it is, it does not appear to have hitherto shown its zygospore.

Section of Olivine Dolerite.—Prof. Hull exhibited a thin section of olivine dolerite from Scalot Hill, near Larne, co. Antrim.

This rock occurs as filling an old volcanic "neck" which pierces through the Chalk limestone and the overlying sheets of basaltic lava which form the crest of Scalot Hill. The rock is seen to be rich in olivine, which forms perhaps one third of the whole mass and polarizes vividly. The other minerals are augite, labradorite, felspar in long plates or prisms, and a little black magnetite.

The rock itself is found to be magnetic when tested by a sensitive needle.

In its general characters the rock agrees with those of other volcanic necks of co. Antrim, such as Carmony Hill and Sleamish, in being rich in olivine, and as having undergone very little alteration since the original consolidation.

Section of Rock from the Summit of Mount Cooke, in New Zealand, obtained by Rev. W. S. Green.—Prof. Valentine Ball showed a section of the foregoing.

In its microscopic characters this rock appeared to consist of a breccia of volcanic materials, angular fragments of quartz and felspar being scattered about in a partly altered, either augitic or hornblendic matrix. This view of its constitution has been confirmed by the microscopic examination of a thin section*. It is a distinctly elastic rock, of which the constituents have been so fractured that there are no unbroken crystalline forms in a condition suitable for determination. The angularity of the particles is against its being of a detrital nature. It would therefore be probably proper to describe it as a dioritic-ash breccia containing quartz.

GEOLOGICAL SOCIETY.

June 20, 1883.—J. W. Hulke, Esq., F.R.S.,
President, in the Chair.

The following communications were read:—

1. "On the Discovery of *Ovibos moschatus* in the Forest-bed, and, its Range in Space and Time." By Prof. W. Boyd Dawkins, M.A., F.R.S., F.G.S.

The specimen described by the author formed part of the collection of the late Rev. F. Buxton, and was obtained by a fisherman from the forest-bed of Trimmingham, four miles from Cromer. The edges are sharp, and the red matrix adhered in places, so that the author regards its geological position as satisfactorily established. It is the posterior half of the upper surface of the skull of an adult female *Ovibos moschatus*. The author describes the range in space and time of this animal, mentioning the different instances in which its remains have been found in Britain. These are, in some cases,

* Prepared by Mr. Cuttall.

undoubtedly postglacial; but he inclines to consider the lower brick-earth of the Thames valley, where the musk-sheep has been found at Crayford, as anterior to the Boulder-clay, which occupies the district to the north. This deposit at Trimmingham, however, is certainly preglacial; and so *Ovibos moschatus* belongs to a fauna which arrived in our country prior to the extreme refrigeration of climate which characterized the glacial epoch, and afterwards retreated northwards to its present haunts, showing, with other evidence, that this epoch did not form a hard-and-fast barrier between two faunas.

2. "On some New or imperfectly known Madreporaria from the Coral Rag and Portland Oolite of the Counties of Wilts, Oxford, Cambridge, and York." By R. F. Tones, Esq., F.G.S.

The author, after pointing out the poverty of the British Corallian rocks in genera and species of corals as compared with the strata of equivalent age on the continent, proceeded to describe a section in the Middle Oolite at Highworth.

The author then described species of *Astrocœnia*, *Dimorpharœa*, and *Latimœandrina*, genera not hitherto recognized in the British Corallian; and for one of the forms he has discovered he proposed a new genus, to which he gives the name of *Crateroseris*. The paper concluded with some remarks on the well-known *Isastrœa oblonga* of the Portland beds.

BIBLIOGRAPHICAL NOTICES.

Mémoires de l'Académie Impériale des Sciences de St. Pétersbourg. 7^e série, tome xxxi. No. 5. *Miscellanea Silurica* III. I. *Supplement* * to the *Monograph of the Russian Leperditia*. II. *The Crustacean Fauna of the Eurypterus-beds of Rootziküll, Oesel.* By Magister FR. SCHMIDT, Fellow of the Academy. With 9 plates. 4to 1883.

IN 1873 M. Fr. Schmidt ("Miscellanea Silurica," L.) published a revision of the then-known *Leperditia* and *Isochilina*, and added several new species, with good illustrations. He figured and described:—

1. *Leperditia grandis*, Schrenck, pp. 9, 10, figs. 1, 3-6 a.
2. *L. Barbotana*, n. sp., pp. 9, 12, figs. 7-9 a.
3. *L. Tyraica*, n. sp., p. 9, figs. 2, 10-12.
4. *L. Angelini*, n. sp., pp. 9, 13, figs. 13-17. Var. *ornata*, Eichw., pp. 9, 14, fig. 18.
5. *L. baltica*, Hisinger, pp. 9, 15.

* "Nachtrag zur Monographie der russischen silurischen Leperditien," &c.

6. *L. Hisingeri*, n. sp., pp. 9, 16, figs. 22, 23.
7. *L. Eichwaldi*, n. sp., pp. 9, 12, figs. 19-21.
8. *L. wiluensis*, n. sp., pp. 10, 17, figs. 27-28 α .
9. *L. parallela*, n. sp., p. 18, figs. 24-26.
10. *L. marginata*, Keyserling, pp. 10, 19, figs. 29-31.
11. *L. Keyserlingi*, n. sp., pp. 10, 20, figs. 32-34.
12. *Ischilina biensis*, Grunewald, pp. 10, 21, fig. 35.
13. *I. punctata*, Eichwald, pp. 10, 22, figs. 36, 37.
14. *I. Maakii*, n. sp., pp. 10, 23, figs. 38, 39.

In the Supplement which the author now gives us he first refers to the letter "On some Silurian *Leperditia*" in the Ann. & Mag. Nat. Hist., March 1882, containing some critical remarks by himself on the *Leperditia* described and figured by T. Rupert Jones in the Ann. & Mag. Nat. Hist. of November 1881; and he intimates that with the continued study of the Russian *Leperditia* he has modified some of his views about the species and varieties then referred to. In this Supplement M. Schmidt first revises the Silurian species from the East-Baltic districts, and then treats of the East-Russian *Leperditia*—*L. marginata*, Keyserling, and *L. wiluensis*, Schmidt, both of which he more fully describes from new material. He also notices the Uralian *L. Barbotana*, Schm., a new Uralian variety of *L. grandis*, Schrenck, and a new species and variety from the Upper-Silurian or Hercynian stage of the South Ural; and from probably the same horizon in the Waigatsch Island he describes three new species and a variety, collected during Baron Norden-skjöld's Jenissei Expedition.

To show the results of M. F. Schmidt's late researches, it may be best to extract his corrected synonymy of the species he has now taken in hand. Thus:—

- P. 8. *Leperditia grandis*, Schrenck, 1873, in Schmidt's Russ. sil. Lep. p. 10, figs. 3-6; Kolmodin, 1879, Ostrac. sil. Gotl. p. 135; F. Schmidt and T. R. Jones, 1882, Ann. & Mag. Nat. Hist. March, p. 169.

Baltic Provinces; Gothland; North-German Drift.

- P. 9. *Leperditia phaseolus* (Hisinger).

Cytherina phaseolus, His., 1837, Leth. Suec. p. 9, pl. i. fig. 1.

Leperditia Angelini, F. Schmidt, 1873, Russ. sil. Lep. pp. 13-18 (with synonyms); Lundgren, 1874, "Om den vid Ramsåsa och Ofvedskloster i Skåne förekommande sandstenens ålder," Lund Univers. Årskrift, vol. x. p. 9.

Leperditia tyraica, Linnarson, 1875, Anteckning från en resa i Skånes silurtrakter in Geolog. föreningens förh. vol. ii. p. 280.

Leperditia Angelini, Krause, 1877, Zeitschr. d. deutsch. geol. Ges. vol. xxix. p. 29.

Leperditia phaseolus, Kolmodin, 1879, Ostrac. sil. Gotl. p. 134, pl. xix. figs. 4, 5.

Leperditia Hisingeri, var. *gracilentia*, Jones, Ann. & Mag. Nat. Hist. November 1881, p. 339, pl. xix. fig. 6.

Leperditia Hisingeri (dwarf form), Jones, 1881, *op. cit.* p. 340, pl. xix. fig. 16.

Leperditia phaseolus, var. *marginata*, Jones, 1881, *op. cit.* p. 341, pl. xix. fig. 15; F. Schmidt and T. R. Jones, *Ann. & Mag. Nat. Hist.* March 1882, pp. 170, 171.

Gothland; Schonen, Christianiafjord; England; Baltic Provinces.

Var. *ornata*, Eichw., is mentioned at p. 10.

P. 11. *Leperditia Eichwaldi*, F. Schmidt, pl. i. fig. 1; and 1873, *Russ. sil. Lep.* p. 17, figs. 19-21.

Oesel and North-German Drift.

P. 11. *Leperditia baltica*, Hisinger, pl. i. figs. 2, 3; F. Schmidt, 1873, *op. cit.* p. 15; Kolmodin, 1879, *op. cit.* p. 134; T. R. Jones, *Ann. & Mag. Nat. Hist.* Nov. 1881, p. 337, pl. xix. fig. 1 (?); Schmidt & Jones, *Ann. & Mag. Nat. Hist.* March 1882, p. 168.

Gothland; Malmö in Christianiafjord; North-German Drift; England (?).

Pp. 11, 12. Var. *contracta*, Jones, *Ann. & Mag. Nat. Hist.* Nov. 1881, p. 337, pl. xix. figs. 2, 3.

England.

P. 13. *Leperditia Keyserlingi*, Schmidt, 1873, *op. cit.* p. 20, figs. 32-34.

Leperditia Hisingeri, Jones, *Ann. & Mag. Nat. Hist.* Nov. 1881, p. 339, pl. xix. fig. 5 (?).

Leperditia Keyserlingi, Schmidt & Jones, *Ann. & Mag. Nat. Hist.* March 1882, pp. 170, 171.

Baltic Provinces; England.

P. 14. *Leperditia Hisingeri*, Schmidt, pl. i. figs. 5-7.

Leperditia Hisingeri, Schmidt, 1873, *Russ. sil. Lep.* p. 16 (partly), fig. 23.

Leperditia Schmidtii, Kolmodin, 1879, *op. cit.* p. 133.

Leperditia balthica, Jones, *Ann. & Mag. Nat. Hist.* Nov. 1881, p. 335, pl. xix. figs. 10, 11.

Leperditia Hisingeri, Schm. & Jones, *Ann. & Mag. Nat. Hist.* March 1882, p. 168.

Gothland, Malmö, Christianiafjord; Baltic Provinces.

Pp. 15, 16. *Leperditia Hisingeri*, var. *abbreviata*, Schmidt, 1883, pl. i. figs. 8-12.

Leperditia baltica, Eichw., 1860, *Leth. ross., anc. période*, p. 1329 (partly).

Leperditia Hisingeri, F. Schmidt, 1873, *op. cit.* p. 16, fig. 22.

Leperditia balthica, var. *contracta*, Jones, *Ann. & Mag. Nat. Hist.* Nov. 1881 (partly), p. 338, pl. xix. fig. 13.

Baltic Provinces.

We gather that M. Schmidt's study of the *Leperditia* leads him to regard Mr. T. R. Jones's

Leperditia balthica, Ann. & Mag. Nat. Hist. Nov. 1881, p. 336, pl. xix. fig. 1, as doubtful: Suppl. p. 11.

Leperditia balthica, var. *contracta*, p. 337, pl. xix. figs. 2, 3, as good: Suppl. p. 12.

Leperditia balthica, p. 336, pl. xix. figs. 4 a, 4 b, as doubtful: Suppl. p. 11.

Leperditia Hisingeri(?), p. 339, pl. xix. fig. 5, as *L. Keyserlingi*: Suppl. p. 13.

Leperditia Hisingeri, var. *gracilentia*, p. 339, pl. xix. fig. 6, as *L. phaseolus*: Suppl. p. 9.

Leperditia balthica, pp. 335, 336, pl. xix. figs. 10, 11, as *L. Hisingeri*: Suppl. pp. 11 and 14.

Leperditia balthica, var. *contracta*, p. 338, pl. xix. fig. 13, as *L. Hisingeri*, var. *abbreviata*: Suppl. pp. 12 and 16.

Leperditia balthica, var. *contracta*, p. 338, pl. xix. fig. 14, as *L. tyraica*, on account of its locality: Suppl. p. 12.

Leperditia phaseolus, var. *marginata*, p. 341, pl. xix. fig. 15, as *L. phaseolus*: Suppl. p. 10.

Leperditia Hisingeri, dwarf var., pp. 340, 341, pl. xix. fig. 16, as *L. phaseolus*: Suppl. p. 10.

Leperditia balthica, var. *contracta*, p. 338, pl. xix. fig. 17, as doubtful: Suppl. p. 12.

At page 18 of his Supplement M. Schmidt describes a fresh *Leperditia marginata*, Keyserling, with its varieties *rotundata* and *subparallela*, from the Waschkina basin, figuring it in pl. i. figs. 13-19. It is the *Cypridina marginata*, Keyserling, 1846, Reise in Petschoraland, p. 288, pl. xi. figs. 16 a-d; *Leperditia marginata*, Schmidt, 1873, Russ. sil. Lep. p. 19, figs. 29-31; and Schm. & Jones, Ann. & Mag. Nat. Hist. March 1882, p. 171.

At page 21, *Leperditia Wiluensis*, Schmidt (1873, *op. cit.* p. 17, figs. 27, 28), is redescribed and figured, pl. i. figs. 20-22. It is from the watershed of the Wilui and Olenek in "East Siberia."

Leperditia Barbotana, Schm. 1873, Russ. sil. Lep. p. 12, figs. 7-9, is further treated of at pp. 22 and 87. It is from the banks of the Kaga, the Belaja, and the Juresenĭ, on the west side of the Southern Ural, and from the Upper-Silurian or Hercynian beds, passing up into the Devonian.

Leperditia Moelleri (and its variety *laevigata*, p. 88), pp. 23 and 87, is a new species from the same district, and is figured in pl. i. figs. 23-25, and pl. v. a, figs. 23, 24.

A new variety (*uralensis*) of *L. grandis*, Schrenck, is given at p. 24 and p. 87, pl. i. figs. 26-28. It is from the bank of the Belaja, below Katschukowa. Some of the limestones of this district are almost wholly composed of *Leperditia*.

Specimens of a *Leperditia*-limestone, probably also of Upper Silurian age, were collected at Cape Gröbenny, in the Waigatsch Island (off the Northern Ural) during Nordenskjöld's expedition to

the Jenissei in 1875; and these yielded the new forms, *Leperditia Nordenskjöldi*, Schmidt, Suppl. p. 25, pl. i. figs. 29-32; *L. waigatschensis*, p. 27, pl. i. figs. 33 a-c; and *L. Lindstroemi*, p. 85, pl. v. a, figs. 17-20, with its variety *mutica*, p. 86, pl. v. a, figs. 21, 22.

The second portion of this Part III. of the "Miscellanea Silurica" deals with the Crustacean Fauna of the *Eurypterus*-beds of Rootzikull in the island of Oesel, at the mouth of the Gulf of Riga, Baltic Provinces.

After some remarks (pp. 28-31) on the strata themselves, their fossil contents, and the results of their careful examination by himself and others, M. Schmidt treats of the HEMIASPIDÆ (pp. 31-34), with their history and characteristics, as shown in the three genera which he refers to this family, namely:—*Pseudoniscus*, Nieszkowski; *Hemiaspis*, H. Woodward; and *Bunodes*, Eichwald. The last genus is described with three species:—*B. lunula*, Eichw., p. 35, pl. i. figs. 34-38, and pl. vii. figs. 1-6; *B. Schrencki*, Nieszk. (*B. lunula*, var. *Schrencki*, Nieszk., in the explanation of plate i. and in the Contents), p. 38, pl. i. figs. 39-43; *B. rugosus*, Nieszk., p. 39, pl. i. figs. 44-47. *Pseudoniscus aculeatus*, Nieszk., is figured and described p. 40, pl. i. figs. 48, 49. The organization and systematic place of the Hemiaspids are treated at pp. 43-46.

The EURYPTERIDÆ and their relationships are discussed at pp. 46-48, and the genus *Eurypterus* described, with two species (*E. Fischeri*, Eichw., with its var. *rectangularis*, and *E. laticeps*), in detail, at pp. 48-64, pls. ii., iii., iii. a, and vi. figs. 6, 7. The history and structure of *Pterygotus* follow (pp. 64 &c.), with a detailed description and full illustration of *Pt. osiliensis*, sp. nov. (pp. 70 &c., pls. iv., v., v. a, figs. 1-16, pl. vi. figs. 1, 2, 3 (var. *laticauda*), 4, 5, and pl. vii. figs. 7, 8, 10, 11, and five woodcuts).

A few, but characteristic, specimens of a *Ceratiocaris* have also been discovered at Rootzikull, in Oesel (p. 83); and these, carefully figured by M. Schmidt in his pl. vi. fig. 8 (telson and two lateral cercopods), fig. 9 (telson spine), pl. vii. fig. 12 (left valve of a carapace), have been referred by him to a new species, *C. Nædlingi* (p. 84, with woodcut, fig. 5), which, as the author observes, is closely related to the English *C. leptodactylus*, McCoy.

These two memoirs, so highly creditable to the Imperial Academy, as results of the palæontological research of one of its active members, have been written with care and exactitude, both as to the observation and collection of facts and the recognition and critical examination of the labours of other palæontologists. The printing is good, the woodcuts are neat, and the numerous and large plates are beautifully delicate, elaborate, and trustworthy.

Proceedings of the Bristol Naturalists' Society. New Series, vol. iv. part i. (1882-83). 8vo. 1883.

IN Natural History this Society has interested itself in many biological and physical subjects during the Session, as appears from the

Reports of the Meetings, pp. 61 &c., and has printed in this volume some very interesting notes:—on a remarkable colony of Alien Plants on an old heap of colliery (?) rubbish at Kingswood (J. W. White); on the Fungi of the Bristol district, part 6 (C. Bucknall); on Ridgway's Catalogue of North-American Birds (H. J. Charbonnier), treating forcibly of the necessity of restraining and limiting the making of genera and species out of closely allied forms, and advocating the *trinomial* system; on the porosity and density of rocks with regard to Water-supply (E. Wethered); on the Iron-turnings Cells and the supposed influence of Points in the liberation of Bubbles (A. M. Worthington); on an apparatus for observing Splashes (A. M. Worthington); the first Telephone (S. P. Thompson); the Rainfall at Clifton (G. F. Burder); and Meteorological Observations, as regards Temperature, at Clifton (H. B. Jupp). Part iii. of the Flora [living] of the Bristol Coal-field, edited by J. W. White, and enumerating the Corallifloræ, forms part of this volume.

Journal of the Royal Geological Society of Ireland. Vol. xvi. part ii.; n. s. vol. vi. part ii. for 1881–82. 8vo. 1882.

Transactions of the Geological Society of Glasgow. Vol. vii. part i. for 1880–82. 8vo. 1883.

IN his Presidential Address, February 20, 1882, the Rev. Dr. Haughton, F.R.S. &c., sketching the progress of the Royal Geological Society of Ireland, pointed out (1) that the popularity of the "original Dublin Geological Society" was due to an unfounded hope that geologists would find coals and minerals sufficient to enable Ireland to compete with the rest of the British Isles in industrial pursuits and in consequent wealth; (2) that the preponderance of physical and stratigraphical over palæontological papers in the 'Transactions' is due to the comparative absence of Secondary and Tertiary strata in Ireland. Dr. Haughton next proceeded to the discussion of the "two speculative problems which await their solution and must occupy a foremost place in the geological discussions of the next fifty years:—I. The absolute duration of Geological Time. II. The physical causes of the Changes of Climate which have, beyond question, taken place in the higher latitudes of the Earth's Surface."

The first of these problems was treated by the Rev. Maxwoll H. Close in his Presidential Address in 1878; and arguments in favour of the great duration of geological time have been based on:—1. The time requisite for the cooling down of the Sun. 2. The present figure of the Earth as compared with its present rate of rotation. 3. The estimate of Geological Time derived from the rate of increase of terrestrial temperature with depth. Dr. Haughton intimates that he has some further evidence in support of the last view. He further draws attention to the important department of research which he terms "Empirical Cosmogony," as elucidated by Mr.

George Darwin's papers on "Tidal Evolution," and by calculations by himself, Prof. Robert Ball, and Mr. A. R. Wallace, on the probable time taken in the deposition of the stratified rocks. Taking these at a thickness of 177,200 feet, 3,000,000 square miles as the area of deposition (on coast-lines for about 30 miles to sea), the land-surface exposed to denudation as 57,000,000 square miles (nineteen times the area of deposition), and the present rate of denudation as 1 foot in 3000 years, the duration of Geological Time equals about 28,000,000 years. It is to be remembered that it is highly probable, Dr. Haughton thinks, that during all geological time down to the close of the Tertiary period, the temperature of the Earth's atmosphere was higher than at present, and the more so the further back we go—the necessary consequences being greater evaporation, greater rainfall, greater denudation, greater trade- and antitrade-winds, greater ocean-currents, and greater facilities for spreading and depositing submarine strata.

It is now thought by Prof. Robert Ball that the great tides caused by the lesser distance of the Moon from the Earth (within some 50,000,000 years) were pregeological. Mr. J. S. Newberry thinks that the Eozoic rocks in North America do not show evidence of tides much greater than those now in action on the Atlantic shores of that region (including, however, the 70-ft. tide of the Bay of Fundy).

Dr. Haughton then took up the "Supposed Causes of Changes in Geological Climates."

I. *The Supposed former effects of Star-heat*, or warm portions of space, suggested by Poisson.

II. *The Obliquity of Ecliptic*. "As this speculation postulates the change of position of the Earth's axis in space, it must be set aside as irrelevant."

III. *Changes in Position of Pole*, that is of the Earth's axis within the Earth itself, causing the poles and equator to shift their positions. Such a change of position of the axis of rotation inside the Earth could be produced by changes of land and water, but not to nearly so great an amount as required to account for the former existence of tropical and subtropical animals and plants at places now in frigid climates, but yielding fossils representing such faunas and floras. Mr. G. Darwin, basing his calculations on the area of the "Pacific depression," finds the maximum change of latitude would be 3°, or 210 miles; and Dr. Haughton, taking Eurasiatica (as elevated since the commencement of Tertiary times) for his basis, finds the change of latitude caused by that elevation to be only 1°, or 70 miles.

On the contrary, there is evidence of change of latitude to the extent of 50°, or 3640 miles, with Silurian corals; 43°, or 3010 miles, with Liassic fossils; 36°, or 2520 miles, with the fossil plants of Grinnell Land; 30°, or 2100 miles, with the fossil plants of Disco.

IV. *Eccentricity and Perihelion-Longitude of the Earth's Orbit*, producing a secular variation in climate. This was proposed by Adhemar, and worked out more fully by J. Croll, J. J. Murphy, and

A. R. Wallace. The change depending on the position of the perihelion is completed in about 21,000 years; while that depending on the eccentricity takes much more time for its course. The eccentricity may have been $\frac{1}{2}$ instead of $\frac{1}{60}$, as at present; but astronomers are unable to say when the maximum eccentricity took place. An alternate glaciation of the northern and southern hemispheres every 21,000 years has been hence deduced by Adhemar, Croll, and Murphy, the glaciation being more or less severe as the eccentricity in the perihelion period was greater or less. Croll places the glaciation of a hemisphere when its winter sol-tice was in aphelion, and Murphy places the glaciation of a hemisphere when its winter solstice was in perihelion.

Dr. Haughton thus expresses this secular inequality in climate:—

“The mean annual temperature of any place varies as the eccentricity of the earth’s orbit and as the range of temperature from summer to winter jointly.” He remarks, “Of these two factors of climate, viz. eccentricity and range of temperature, the first is astronomical, and the second terrestrial, depending on distribution of land and water, on ocean-currents and prevailing winds;” and he adds, “if we suppose the terrestrial factor to be the same while the eccentricity attains its maximum, the greatest possible change in mean annual temperature for any place on the earth’s surface turns out to be less than 5° F.; and, in order to produce a sensible effect upon climate, we must suppose that the annual range (terrestrial factor) must vary also by variation in the distribution of land and water.” Taking several examples of the present annual range of temperature at places where Miocene plant-beds exist, and calculating what the annual range must have been for those fossils, and allowing for any fairly possible distribution of land and water, Dr. Haughton shows that “change of eccentricity of the earth’s orbit is not sufficient to account for former geological climates.”

V. *Geographical Distribution of Land and Water.* This is shown in the foregoing discussion to be inadequate as a cause for the past changes in geological climate; and Dr. Haughton indicates that Mr. Wallace strongly supports the view of the relative persistence of the continental and oceanic areas, and that the present differences of the northern and southern hemispheres have existed from the beginning and are due to an eccentric position of the earth’s centre of gravity. The southern hemisphere has thus been always more under water than the northern, and always will be. It is warmer than the northern, because it receives three tepid currents of equatorial water instead of one; and continental climates are and always have been characteristic of the northern, and insular climates of the southern hemisphere.

VI. *Alterations in Sun-heat.* This is accepted by Dr. Haughton as the most probable of all causes of change in geological climate, whether cold or hot. He thinks “that the Glacial period or periods were non-periodic, that they affected both hemispheres simultaneously, and depended altogether on physical changes in the sun itself, and not on the physical or astronomical conditions of the

earth." Mathematical formulæ, concerned with the foregoing discussions, are appended to the Address.

In the same volume Dr. E. Hull gives a clear statement of his views as to the occurrence of Laurentian beds in Donegal and elsewhere in Ireland, and a paper on the metamorphic rocks and minerals of Sligo and Leitrim, with analyses by Mr. E. T. Hardman. Mr. G. A. Kinahan supplies very interesting papers on the gold of Ireland and the geological structure of Bray Head. Mr. G. H. Kinahan explains why some palæozoic rocks in Galway and elsewhere cannot be regarded as Laurentian; and supplies a short but valuable illustrated note on some moraines on Mount Leinster, in counties Wicklow and Carlow. Prof. V. Ball gives a catalogue of the meteorites, of which there are specimens in the museums of Dublin, and includes the published analyses of four meteorites known to have fallen in Ireland.

The geologists of Glasgow, like those of Ireland, have brought down their published work to 1882; but, beginning with 1880, they make a thicker volume for this issue. It is richer in palæontological researches than the Irish Journal, on account of the great opportunities for collecting fossils, both from the varied Carboniferous deposits of Lanarkshire and neighbourhood and from the Post-tertiary beds of the Clyde valley. Of these last, as exposed in the dock of Garvel Park, at Greenock, Mr. D. Robertson gives a full account, with long lists of the fossils obtained. Graptolites and other fossils from Dumfriesshire are treated of by Mr. J. Dairon. The palæontology of Lesmahagow, Silurian and Carboniferous, is studied by Dr. J. R. S. Hunter, and some fossiliferous beds in the Beith and Daldry district by Mr. Robert Craig. Some fish-remains from East Kilbride are noted by Mr. James Coultts; Mr. John Young discriminates some Carboniferous *Fenestellæ*; and Mr. W. E. Koch gives an interesting note on Mull and its leaf-beds.

There are several good memoirs also on local geology (Muirkirk, Isle of Man, Renfrewshire, Shetland, &c.), and on boulders, limestones, and igneous rocks; also on the bismuth and tin deposits of Australia. Several of these papers are illustrated with plates.

Neither last nor least in this new volume of the 'Transactions' is an excellent account of the "Origin and Early History of the Geological Society of Glasgow" by Mr. T. M. Barr, who writes carefully and enthusiastically, and has much real pleasure in showing that good work has been done by the members, and that the society may fairly claim to have made its mark on the progress of geological science.

MISCELLANEOUS.

A proposed new 'Nomenclator Palæontologicus.'

WE have received a printed report on the subject of a new 'Nomenclator Palæontologicus,' prepared by Dr. M. Neumayr, of
Ann. & Mag. N. Hist. Ser. 5. Vol. xii. 10

Vienna, to be submitted to a meeting of the Nomenclature Committee of the International Geological Congress which will be held at Zurich on the 7th of August. As Bronn's 'Nomenclator' dates back to the year 1858, and nothing of the kind has since been attempted, we can only hope that Dr. Neumayr's proposal may be carried out on the scale and with the completeness suggested in his admirable report.

He commences by discussing the plans adopted in the only two works which more or less occupy the ground, namely the above-mentioned 'Nomenclator' of Bronn and d'Orbigny's 'Prodrome,' both of which are of old date. The plan of the latter, as he very justly points out, renders it far more useful to the stratigraphist than to the palæontologist—that is to say, regarding it from the nomenclatorial point of view; for of course, as indicated by Dr. Neumayr, the 'Prodrome' must always be consulted by the palæontologist on account of the many new genera and species established in it.

Bronn's plan, on the contrary, was purely palæontological; stratigraphical considerations had no influence whatever upon the general arrangement of his work. In the 'Nomenclator' properly so called, which occupies his first two volumes, he has given a purely alphabetical list of all the names existing in palæontology up to his date (*i. e.* the generic names are arranged alphabetically and the specific names also alphabetically under each genus), with indications of synonymy and references to the works in which the different forms are described; while the so-called "Enumerator," constituting the third volume, forms a complete classified index to the preceding portion, and at the same time furnishes indications of the stratigraphical distribution of the species by means of a series of vertical columns. Of course in five-and-twenty years palæontology has enormously outgrown this work of Bronn's; but every one who has had any thing to do with palæontological work must own that he owes a deep debt of gratitude to the man who undertook and so successfully carried out a work of such labour and research.

"Bronn's plan of an alphabetical enumeration," says Dr. Neumayr, "has the great advantage that no terminal index is necessary, that doubts as to the arrangement of different forms never stand in the way, and finally that in those cases in which formerly species belonging to different types of the animal kingdom were thrown together under the same generic name, no complication arises from this confusion. But great as these advantages may be, it is impossible not to see that still more important considerations are in favour of systematic separation in accordance with the great primary groups of the animal and vegetable kingdoms: in the first place, in palæontological researches one usually has to do only with representatives of one of the primary divisions at a time; and then we need only make use of the volume relating to it, and not of the whole book; so that a simplification of the work is introduced. Above all, however, we must be governed by practical considerations as to the mode of bringing out the work. If every thing is to be brought into

alphabetical sequence, the printing cannot be commenced until all the manuscripts are ready, which will cause great delay in its appearance; by the arrangement under the principal types, on the contrary, the printing of any volume can begin as soon as the manuscript for it is in hand. In the one case the neglect of a single contributor will delay the appearance of the whole book, in the other case only that of a single volume. The difficulties which may arise from genera of doubtful position may be got over by cross references. That the addition of an 'Enumerator' is very desirable need hardly be indicated."

While we cannot help feeling that Bronn's plan, pure and simple, is absolutely the best, especially in view of the second advantage belonging to it, which Dr. Neumayr has pointed out, with relation to genera containing species which later researches have proved to belong to different primary divisions of the animal kingdom, and indeed with relation to doubtful organisms of all kinds, we cannot, on the other hand, deny the force of his arguments in favour of the division of the 'Nomenclator' in accordance with the great groups of the animal and vegetable kingdoms, more especially when we look at the formidable dimensions which he considers the new work will attain. He proposes to divide it into twelve volumes, as follows:—

Vol. I. Cryptogamia.	Vol. VII. Mollusca.
II. Phanerogamia.	VIII. Arthropoda.
III. Protozoa.	IX. Vertebrata.
IV. Coelenterata.	X. & XI. Enumerator.
V. Echinodermata.	XII. Index.
VI. Vermes and Molluscoida.	

It seems to us that, supposing the suggested arrangement to be carried out as above, the usefulness of the work will very much depend upon the completeness of the index, which ought to furnish a guide to every employment of a name (generic or specific) in any part of the book, and in the case of specific names to indicate in every case the genus under which the species has been placed in each particular instance. With such an index as this nearly all the advantages of Bronn's plan will be again realized.

Dr. Neumayr further enters upon a statement of the principles on which he proposes that the work should be carried out, which seem to us to be exceedingly well conceived. Two points are especially deserving of approval, namely:—1. The regulation that no changes of names shall be made in the 'Nomenclator;' and 2, the proposal to avoid as much as possible all conventional signs, and to adopt a system of abbreviations in the citations such as will be at once intelligible to every one "who possesses some knowledge of literature," a course which we hope may lead to the suppression of that most vicious system of quoting from separate copies of papers without any reference to the periodical works in which they occur, which now prevails to a very serious extent. Dr. Neumayr's remark as to people possessing "some" knowledge of literature would

seem to indicate that he is alive to the inconveniences of this practice; and his selection of the Royal Society's List of Scientific Papers as a model points in the same direction. We can only say that we hope his proposals may be carried out upon, or nearly upon, the lines indicated in his report; in this case he and his *collaborateurs* will richly merit the thanks of all palæontologists. Under *favourable circumstances* he thinks the first volume might appear in from two to three years, and the whole be finished in from eight to ten years!

Selenotropism in Plants. By M. C. MUSSET.

Being struck with the influence exerted by light of very little intensity upon the so-called *heliotropic* movements of plants, the author, in order to vary the experiments, adopted the reflected light of the moon as his sole illumination. He sowed in pots seeds of plants well known for their phototropic sensibility, such as *Lens esculenta*, Mönch, *Ervum lens*, Linn., *Vicia sativa*, Linn., &c. When the young plants were a few centimetres long he placed them in a very dark place, where they remained until the night of the experiment. The stems became slender, long, and white; the leaves, which were but little developed, alone had a slightly yellow tinge. During the night of 23–24th February, with a very clear sky, those seedlings were placed in a large window looking to the south, so that they received the direct light of the moon from 9 p.m. to 3 a.m. After a very few minutes of exposure the stems became bent, with the concavity and the terminal bud always presented to the moon, and following it in its course; only about 2 a.m., owing to the changed position of the moon, the bow became nearly straight. The seedlings were then carried to another window looking westward; and a new influence was produced, and continued until the moment of the disappearance of the moon behind the mountain. After a pause of a few minutes the stems then erected themselves more or less under the influence of internal causes and geotropism. To these movements, which he observed for three successive nights, the author gives the name of *selenotropism*.—*Comptes Rendus*, March 5, 1883, p. 663.

*Jumping Seeds and Galls**. By CHARLES V. RILEY.

Having recently received some fresh specimens of so-called "Mexican Jumping Seeds," or "Devil's Beans," as they are popularly called, I take occasion while yet they are active to exhibit them to the society. It will be noticed that these seeds are somewhat triangular, or of the shape of convolvulus-seeds, there being two flat sides meeting at an obtuse angle, and a convex one, which has a median carina. They not only roll from one side to another, but

* Read before the Biological Society of Washington, November 24, 1882.

actually move by jerks and jumps, and will, when very active, jump at least a line from any object they may be resting on. The actual jumping-power has been doubted by some writers; but I have often witnessed it. To the uninitiated these movements of a hard seed seem little less than miraculous. They are induced by a plump, whitish, lepidopterous larva which occupies about one fifth of the interior, the occupied seed being, in fact, but a hollow shell, with an inner lining of silk which the larva has spun. The larva looks very much like the common apple-worm (*Carpocapsa pomonella*), and belongs, in fact, to the same genus. It resembles it further in remaining for a long time in the full-grown larva state before transforming, so that the seeds will keep up their motion throughout most of the winter months. When about to transform, which is usually in the months of January and February, it cuts a neat circular door in the convex side of its house, strengthens the same with silk, spins a loose tube of silk within the seed, and therein transforms to the pupa state. The moth soon afterwards pushes its way out from the little door prepared for it.

The moth was first described in 1857 as *Carpocapsa saltitans* by Prof. J. O. Westwood*, and afterward as *Carpocapsa Dehaisiana* by Mons. H. Lucas†.

In regard to the plant on which these seeds occur there is much yet to learn; and I quote what Mr. G. W. Barnes, president of the San Diego Society of Natural History, wrote me in 1874 concerning it, in the hope that some of the botanists present may recognize it:—

“ARROW-WEED (*Yerba de flecha*).—This is the name the shrub bears that produces the triangular seeds that during six or eight months have a continual jumping movement. The shrub is small, from 4 to 6 feet in height, branchy, and in the month of June and July yields the seeds, a pod containing three to five seeds. These seeds have each a little worm inside. The leaf of the plant is very similar to that of the garambullo, the only difference being in the size, this being a little larger. It is half an inch in length and a quarter of an inch in width, a little more or less. The bark of the shrub is ash-coloured; and the leaf is perfectly green during all the seasons. By merely stirring coffee, or any drink, with a small branch of it, it acts as an active cathartic. Taken in large doses it is an active poison, speedily causing death unless counteracted by an antidote.”

In a recent letter he states that he is informed that the region of Mamos, in Sonora, is the only place where the plant grows; that the tree is about 4 feet high, and is a species of laurel, with the

* Proc. Ashmolean Soc. of Oxford, 1857, t. iii. pp. 137, 138; see also Trans. Lond. Ent. Soc. ser. 2, 1858, t. iv. p. 27, and Gard. Chron. 1859, Nov. 12, p. 909.

† “Note sur les grains d’une Euphorbiacée de Mexique sautant au dessus du sol par les vibrations d’une larve de l’ordre des lépidoptères vivant en dedans,” Ann. Soc. Ent. de France, sér. 3, t. vi. Bull. pp. 10, 33, 41, 44 (1859), t. vii. pp. 561-566.

leaves of a dark varnished green. "It bears the seeds only once in two years. The tree is called *Brincador* (jumper), and the seeds are called *Brincaderos*. The seeds are more quiet in fair weather, and lively on the approach of a storm."

Prof. Westwood mentions the fact that the plant is known by the Mexicans as "*Colliguaja*;" and Prof. E. P. Cox, formerly State Geologist of Indiana, now living on the Pacific coast, informs me that the shrub has a wood something like hazel or whahoo; that the leaf is like a broad and short willow leaf. He confirms the statement as to its poisonous character; that a stick of the shrub, when used by the natives to stir their "penola" (ground corn-meal, parched), purges, and that the shrub is used to poison arrowheads. The plant is undoubtedly Euphorbiaceous.

The peculiarity about this insect is that it is the only one of its order, so far as we know, which possesses this habit; and it is not easy to conceive of what benefit this habit can be other than the possible protection afforded by working the seed, after it falls to the ground, into sheltered situations.

The true explanation of the movements of the larva by which the seed is made to jump was first given by me in the 'Transactions of the Saint Louis Academy of Science' for December 6, 1875 (vol. iii. p. cxc).

The jumping-power exhibited in this "seed," however, is trifling compared with that possessed by a little gall which I also exhibit. This gall, about the size of a mustard-seed, and looking very much like a miniature acorn, is found in large numbers on the underside of the leaves of various oaks of the white-oak group, and has been reported from Ohio, Indiana, Missouri, and California. It falls from a cavity on the under side of the leaves, very much as an acorn falls from its cup, and is sometimes so abundant that the ground beneath an infested tree is literally covered. It is produced by a little black *Cynips*, which was described as *Cynips saltatorius* by Mr. Henry Edwards. The bounding motion is doubtless caused by the larva which lies curved within the gall, and very much on the same principle that the common cheese-skipper (*Piophilæ casei*) is known to spring or skip. Dr. W. H. Mussey, of Cincinnati, in a communication to the Natural History Society of that city, December 1875, states, in fact, that such is the case, though members of the California Academy who have written on the subject assert that the motion is made by the pupa, which I think very improbable. At all events the bounding motion is great, as the little gall may be thrown 2 or 3 inches from the earth; and there are few things more curious than to witness, as I have done, a large number of these tiny galls in constant motion under a tree. They cause a noise upon the fallen leaves that may be likened to the pattering of rain.—*Proc. United States Nat. Mus.* p. 632.

The "Crag Mollusca."

In the last number of the 'Annals' Mr. Searles V. Wood expressed his opinion that *Purpura tetragona* of his late father's Monograph on the Crag Mollusca was a variety of *Murex erinaceus*, and not of *Purpura lapillus*, in which Prof. Prestwich placed it on my authority, in his papers on the Crag beds of Norfolk and Suffolk. This question involves a difference not merely of a specific but of a generic and even family character. In *Murex* the canal is of moderate length, and is more or less covered over or closed above; in *Purpura* the canal is very short and quite open. All the specimens which I have seen of *Purpura tetragona*, including the types in the British Museum, belong (as I consider) to the latter genus, in which Mr. Wood's father properly placed it. Some Crag specimens of *Purpura lapillus* are carinated, and others are more or less cancellated, as in the variety *tetragona*. The sculpture of *Murex erinaceus* is different. I may observe that the specific or varietal name *tetragona* ought not to be accentuated like the English word "tetragonal," but that the penultimate syllable is long, as in the Latin word "tetragonus."

J. GWYN JEFFREYS.

On a new Crinoid from the Southern Sea. By P. HERBERT
CARPENTER, M.A., Assistant Master at Eton College.

Among the collections of the late Sir Wyville Thomson a small *Comatula* has recently been discovered which was dredged by the 'Challenger' at a depth of 1800 fathoms in the Southern Sea. Although it is unusually small, the diameter of the calyx being only 2 millim., the characters presented by this form are such as to render it by far the most remarkable among all the types of recent Crinoids, whether stalked or free. The name proposed for it is *Thaumatocrinus renovatus*.

It has only five arms, and in this respect resembles *Eudiocrinus*. But the basals, instead of becoming transformed into a rosette as in that genus, persist on the exterior of the calyx, and form a closed ring of relatively large plates, which rest upon the centrodorsal. They support a ring of ten plates, five of which, alternating with the basals, bear the arms, and are therefore the radials. These radials, however, do not meet one another laterally; for they alternate with five plates slightly smaller than themselves, which rest upon the basals, and, with one exception, terminate in a free edge at the margin of the disk. The exception is the interradiial of the anal side, which bears a short and tapering arm-like appendage of five or six joints. It has no special relation to the anal tube, the lower part of which, like the peripheral portion of the disk, bears a pavement of anambulacral plates. But the centre of the disk is occupied by a relatively large and substantial oral pyramid; so that the disk in its general aspect resembles that of *Hyocrinus*.

Thaumatoocrinus is thus distinguished by four striking peculiarities:—

(1) The presence of a closed ring of basals upon the exterior of the calyx.

(2) The persistence of the oral plates of the larva, as in *Hyocrinus* and *Rhizocrinus*.

(3) The separation of the primary radials by interradials which rest on the basals.

(4) The presence of an arm-like appendage on the interradial plate of the anal side.

Taking these in order—

(1) No adult *Comatulæ*, except the recent *Atelecrinus* and some little-known fossils, has a closed ring of basals; and even in *Atelecrinus* they are quite small and insignificant.

(2) In all recent *Comatulæ*, in the *Pentacrinidæ*, and in *Bathycrinus*, the oral plates of the larva become resorbed as maturity is approached. In *Thaumatoocrinus*, however, they are retained, as in *Hyocrinus*, *Rhizocrinus*, and *Holopus*, representatives of three different families of Neocrinoids.

(3) There is no Neocrinoid, either stalked or free, in which the primary radials remain permanently separated as they are in *Thaumatoocrinus* and for a short time after their first appearance in the larva of ordinary Crinoids. The only Palæocrinoids presenting this feature are certain of the *Rhodocrinidæ* (as understood by Wachsmuth and Springer), e. g. *Reteocrinus*, *Rhodocrinus*, *Thylacocrinus*, &c. In the two latter, and in the other genera which have been grouped together with them into the section *Rhodocrinites* (W. and S.), there is a single interradial intervening between every two radials, and resting on a basal just as in *Thaumatoocrinus*. But in the Lower Silurian *Reteocrinus* (of Billings, emend. W. and S.) the interradial areas contain a large number of minute pieces of irregular form and arrangement.

(4) It is only, however, in *Reteocrinus* and in the allied genus *Xenocrinus*, Miller, which is also of Lower Silurian age*, that an anal appendage similar to that of *Thaumatoocrinus* is to be met with.

Of the four distinguishing characters of *Thaumatoocrinus*, therefore, one appears in one or perhaps in two genera of *Comatulæ*; another is not to be met with in any *Comatula*, though occurring in certain stalked Crinoids; while the two remaining characters are limited to one family of the Palæocrinoids, one of them being peculiar to one, or at most two genera which are confined to the Lower Silurian rocks.

Their reappearance in such a specialized type as a recent *Comatula* is therefore all the more striking.—*Proc. Roy. Soc.* 1883, No. 225, p. 138.

* *Reteocrinus* occurs in the Trenton Limestone of Ottawa and in the Hudson-river group of Indiana and Ohio. *Xenocrinus* has as yet been found in the latter group only. I cannot help suspecting that a better knowledge of this type will lead to its absorption into *Reteocrinus*.—P. H. C.

THE ANNALS

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[FIFTH SERIES.]

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XVIII.—*On the Classification of the Orders of Orthoptera and Neuroptera.* By A. S. PACKARD, Jun.*

IN the forthcoming third report of the U. S. Entomological Commission we have endeavoured to ascertain the position of the Orthoptera in reference to allied ametabolous insects. The following pages are extracted from the chapter, with some omissions.

We have examined the fundamental characters of the head, thorax, and abdomen (points neglected by most systematic writers), not spending much time on the peripheral, *i. e.* the superficial, adaptive characters of the mouth-parts, wings, and legs, which have been elaborated by systematic entomologists, believing that by this method perhaps more thorough and better-grounded views might result. The outcome has been to lead us to separate the Neuroptera, as defined further on, from the Pseudoneuroptera, and to regard these two groups, with the Orthoptera and Dermaptera, as four orders of a category which may be regarded as a superorder, for which the name Phyloptera is proposed, as these four orders are probably closely allied to, if not in some cases identical with, the stem or ancestral groups from which probably all the higher

* From a separate impression from the 'American Naturalist' for August 1883, communicated by the Author.

orders (the Hemiptera, Coleoptera, Diptera, Lepidoptera, and Hymenoptera) have originated.

We will first briefly summarize the characters, as we understand them, of the Phyloptera as a whole; then the distinguishing marks of the four orders.

Superorder PHYLOPTERA*.

The mouth-parts are free, adapted invariably for biting, the mandibles being toothed and adapted for chewing; the first maxillæ separate, with three divisions, the outer bearing usually five-jointed palpi; the second maxillæ united to form a labium divided into a submentum, mentum, and ligula, the latter varying much, being either cleft (Pseudoneuroptera) or entire (Neuroptera), and bearing usually a three-jointed palpus. This is the primitive elementary condition of the mouth-parts, and such as obtains in Coleopterous larvæ. The head is notable from the great development of the epicranium. The clypeus is often divided into two portions, a posterior (post-clypeus) and anterior (anteclypeus); in the other and higher orders the clypeus is entire.

The prothorax is usually very large and square; but in a few families, as the Phryganeidæ, Panorpidæ, Psocidæ, Libellulidæ, and Ephemeridæ, it is small and collar-like. There is a marked equality in size and form of the meso- and metathorax; in most Orthoptera and some Pseudoneuroptera and Neuroptera the metathorax is often even larger than the mesothorax; in this respect the Phyloptera differ from any of the higher Hexapoda. In both of the two hinder segments of the thorax the four tergal sclerites, viz. the præscutum, scutum, scutellum, and postscutellum, are each well developed, and more equably so than in any other order. The scutum is deeply excavated in front to receive the often large subtriangular or cordate præscutum; and in some genera the scutum is, so to speak, cleft in two by the meeting of the præscutum and scutellum in the median line. The flanks of the thorax or pleurites, are often very large, and the episternum and epimerum are broad, oblong, or squarish; and these sclerites are sometimes subdivided into an upper and a lower division (supra- and infra-epimerum or episternum). The sternum is often large, flat, and broad; it is sometimes divided into a sternum and præsternum.

The wings are usually net-veined, often with numerous longitudinal veins, the branches of the subcostal, median, and submedian veins being either very long and parallel with the

* From *φύλον*, gens, nation; *πτερόν*, wing.

longitudinal axis of the wing, or numerous and small (especially in the hind wings of Orthoptera).

The hind wings are often (Orthoptera and Odonata) broader and larger than the anterior pair, the metathorax in such cases being a little larger than the mesothorax.

The abdomen has in this group, including representatives of the Neuroptera, Orthoptera, Dermaptera, and Pseudoneuroptera, besides a tenth nearly complete segment, the rudiments of an eleventh uromere, represented by a tergite forming the supraanal triangular plate. Well-developed jointed cercopoda occur in the Orthoptera and Pseudoneuroptera, while the forceps of Forficula (Dermaptera) are undoubtedly modified cercopoda. An ovipositor occurs in the Neuroptera (Panorpidae) and Orthoptera.

The metamorphosis is incomplete in all the orders of Phyloptera except the more recent and higher order, *i. e.* the Neuroptera (in Erichson's sense), in which the transformations are complete, the pupa being quiescent and wholly unlike the larva.

The relative standing of the four orders of Phyloptera is shown in the table or genealogical tree of the winged insects on page 154.

The sequence of the orders, such as we are compelled to adopt in writing or speaking of them, is difficult to decide upon. Beginning with what on the whole may be regarded as the lowest order, we might first take up the Dermaptera, which are, in most respects, the most generalized forms, and stand nearest to the Thysanura (*Japyx*).

The following is the succession of orders, placing the lowest uppermost :—

Dermaptera, Burm.

Orthoptera, Linn.

Pseudoneuroptera, Erichson.

Neuroptera, Linn., as restricted by Erichson.

Before discussing the relative standing of these orders, we will briefly indicate the more salient and generally applicable differential characters, especially what we regard as the more fundamental ones, but slightly touching upon the mouth-parts and wings, these being peripheral and more adaptive characters and liable to greatest variation, and being of less value in characterizing the orders of Phyloptera.

Order 1. DERMATOPTERA.

Forficula presents so many features separating it from the

Orthoptera, and is so composite a form, that it should be regarded as the type of a distinct order, in which it was originally placed by Leach, Kirby, Burmeister, and Westwood. Its composite nature is seen both in the elytra and the hind wings, which anticipate the Coleopterous type of wings. On the other hand, the larvæ resemble *Japyx*, the Thysanuran, with its anal forceps; and in most respects *Forficula* is the lowest, most decided stem form of the Phyloptera.

The Dermaptera are characterized by the flatness of the body and the large terminal forceps. The head is flat, horizontal in position, while the presence of the V-shaped epicranial suture is a sign of inferiority, as it is characteristic of Thysanura and Platypteran larvæ as well as of Coleopterous larvæ. The remarkable thoracic structure, which is described further on, as well as the curious overlapping of the abdominal tergites, forbid our uniting the Dermaptera with the Orthoptera. The small short elytra and the very large, rounded, longitudinally and once crossfolded hind wings, which remind us rather of the Coleoptera than Orthoptera, are also important diagnostic features. Finally the metamorphosis of the Dermaptera is even less complete than that of the Orthoptera.

The ligula is bifid, being divided into a pair of two-jointed paraglossæ. The labium is thus similar to that of the Orthoptera, though scarcely more like them than like *Termes*.

Order 2. ORTHOPTERA.

The head is more or less vertical in position; the front is very large, broad, and long, the epicranial region very large and often hypertrophied. The clypeus is large and subdivided as in Pseudoneuroptera. In the Orthoptera, as a rule, the deeply-cleft ligula is indistinctly four-lobed, the outer pair of paraglossæ very well developed, while the inner pair is minute or undeveloped, as in the Acrydii, especially *Caloptenus*; but in the Locustariæ the ligula is four-lobed, and in the Gryllidæ decidedly so. In the Mantidæ and Blattariæ the ligula is plainly four-lobed, nearly as much so as in the Termitidæ. In the Phasimidæ the ligula is intermediate in form between the Mantidæ and Locustariæ.

The prothorax is usually remarkably large, particularly the notum. The meso- and metanotum exactly repeat each other, and the metanotum is usually (Acrydii and Locustariæ) longer and larger than the mesonotum, the hind wings being almost uniformly much larger than the anterior pair. The pleurites are very large and square as well as high, the episterna and epimera being large and oblong and equally developed. The

sternites are very large and broad. The coxæ are sometimes (*Blatta*) very large; the hind legs in the Acrydii are much larger than the anterior pairs. The fore wings are narrower than the hinder pair, and show a slight tendency to become subelytriform; on the other hand, the hind wings are very large and broad, distinctly net-veined, with numerous longitudinal veins, and they fold up longitudinally.

The abdomen has eleven uromeres, the eleventh forming a triangular tergite. The cercopoda are often (*Blatta*, *Mantis*, &c.) multiarticulate and well developed, while the ovipositor is often large and perfect. The metamorphosis is more incomplete than in the Pseudoneuroptera.

With the exclusion of the Forficulariæ, the Orthoptera, as here restricted, are a tolerably well-circumscribed group; and though there are great structural differences between the families, yet the connexion or sequence of the families from the Blattariæ through the Phasmidæ and Mantidæ and Acrydii to the Locustariæ, and finally the highest family, the Gryllidæ, is one which can be distinctly perceived. There is no occasion for a subdivision of the order into groups higher than families, as the Blattariæ are but a family removed from the Mantidæ.

Order 3. PSEUDONEUROPTERA, Erichson.

It is difficult, if not impossible, to satisfactorily characterize by a sharp-cut definition this very elastic order. As regards the thorax, there is no uniformity in the structure that we have been able to discover, nor is there in the structure of the wings, nor more than a general resemblance in the mouth-parts.

The definition of the Pseudoneuroptera in Hagen's 'Synopsis of the Neuroptera of North America,' as given in the analytical table, which is stated in a footnote to have been prepared at the request of the Smithsonian Institution by Baron Osten Sacken, gives no fundamental characters based on a study of the trunk. Those mentioned are what we have called peripheral characters, *i. e.* those drawn from the mouth-parts, wings, and appendages. So far as we know, no satisfactory definition of the Pseudoneuroptera has ever been given. In Hagen's 'Synopsis,' among the other superficial characters given are these:—"Lower lip mostly cleft;" "antennæ either subulate and thin, the tarsi three- to five-articulate, or setiform or filiform, in which case the tarsi are two- to four-articulate." These characters, though superficial, are the most important yet presented, perhaps (disregarding the

metamorphosis), for separating the Pseudoneuroptera from the genuine Neuroptera. But the cleft labium is also to be found in Orthoptera; and among the Orthoptera, which usually have five-jointed tarsi, the Mantidæ have four tarsal joints. The Perlidæ, Odonata, and Ephemerina have been by Gerstæcker (Peters and Carus's 'Zoologie') associated with the Orthoptera under the name *Orthoptera amphibiotica*; but such an alliance does not seem to us to be entirely a natural or convenient one; it is simply transferring a mass of heterogeneous forms to what, as now limited, is a natural and well circumscribed category; and yet we confess that it is difficult to give diagnostic adult characters separating the Pseudoneuroptera from the Orthoptera, though the general facies of the Orthoptera is quite unlike that of the Pseudoneuroptera.

In the Pseudoneuroptera, beginning with the more generalized forms, the Perlidæ and Termitidæ, the labium (second maxillæ) is deeply cleft, the cleft not, however, in these or any other insects, extending to the mentum, or even clear through the palpiger. Each lobe is also cleft, so that the ligula is really four-lobed; the outer lobes are called by Gerstæcker* the "lamina externa," and the inner the "lamina interna." These finger-shaped non-articulated fleshy lobes appear to be homologous with, or at least suggest, the outer pair of paraglossæ of the Coleoptera and Hymenoptera. In the Perlidæ the four lobes of the ligula are well developed, and the lobes of the inner pair are broader than the outer. In the Termitidæ the lobes are well developed, but the inner pair of lobes is either one half or not quite so wide as the outer paraglossæ; the palpiger is cleft. In the Embidæ, according to Savigny's figures, the ligula is four-lobed, but the inner pair are narrow and rudimentary.

In the Odonata, according to Gerstæcker's excellent drawings, the ligula varies much. In *Gomphus* it is entire; in some of the higher Libellulinæ only two-lobed; but in *Æschna* it is four-lobed, the outer lobe slender but separate from the palpus. In *Calopteryx* the ligula is widely cleft, the two inner lobes are wide apart, while the outer pair are consolidated with the labial palpi. Owing to the specialized nature of the labial palpi, the mouth-parts of the Odonata are sufficiently *sui generis* and distinctive to prevent their being placed among the Orthoptera, even if the thorax were not so dissimilar. In the aborted labium and other mouth-parts of the Ephemerina we also have strongly-marked characteristics

* "Zur Morphologie der *Orthoptera amphibiotica*," Aus der Festschrift zur Gesellsch. naturforsch. Freunde, 1873.

forbidding their being placed in the Orthoptera; were it not for the strong resemblance of the Termitidæ to the Orthoptera (Blattariæ), probably no one would have thought of carrying the Pseudoneuroptera over into the Orthoptera.

The relative proportion of the head and sclerites varies greatly; no general rule can be laid down as to the relative proportions of the epicranium and of the clypeus or of the gular region.

On this account I had at one time decided to split the group into two, and to restrict Erichson's Pseudoneuroptera to the Platyptera*, and to adopt Latreille's term Subulicornia for the Odonata and Ephemerina (Subulicornes of Latreille). It may, however, be best for the sake of clearness to retain Erichson's order Pseudoneuroptera as he indicated it, and to dismember it into what may be regarded, provisionally at least, as three suborders:—

1. *Platyptera* (Termitidæ, Embidæ, Psocidæ, and Perlidæ = Corrodentia and *Orthoptera amphibiotica* in part).
2. *Odonata* (Libellulidæ).
3. *Ephemerina* (Ephemeridæ).

It is comparatively easy to give well-grounded differential characters for these three suborders. They are so distinct that they may perhaps hereafter be regarded as entitled to the rank of orders, or the Pseudoneuroptera may be dismembered into the Pseudoneuroptera and Subulicornia (Odonata and Ephemerina).

1. *Platyptera*.—The body is flattened; the head horizontal. The pronotum is large, broad, and square. The meso- and metanotum are remarkable on account of the imperfect differentiation of the scutum and scutellum; the latter is indefinite in outline, but very large. The flanks (pleurites) are, when long, oblique or are short. The sternites are usually very large and broad. There are often eleven uromeres.

2. *Odonata*.—While the Odonata and Ephemerina are somewhat alike as regards the form and venation of the fore wings, in their mouth-parts and thorax they are entirely unlike. The Odonata are remarkable for the great dorsal (tergal) development of the mesepisterna and the enormous development of the meso- and metapleurites in general, while

* This name (πλατύς, flat, πτερόν, wing) is in allusion to the wings, which the majority (the Psocidæ folding their wings rather roof-like) fold flat on the back. The Isoptera of Brullé comprise the Termitidæ.

the notum of meso- and metathorax, though of the same type as in the Orthoptera, is minute in size. The prothorax is very small, both dorsally and on the sides forming a collar.

The wings are as markedly net-veined as in the Orthoptera, though the hinder pair are not folded longitudinally as in that order. The Odonata literally live on the wing, and thus the shape of the sclerites of the notum of the wing-bearing segments approaches that of the Orthoptera, although the prothorax is remarkably small compared with that of the Orthoptera, and forbids their union with this order, as was done by Gerstäcker and other German entomologists. The head of the Odonata is remarkable for the enormous size of the eyes and the consequent great reduction in size of the epicranium as compared with the large epicranium of the Orthoptera. The mouth-parts are like those of the Orthoptera, except that the second maxillæ form a remarkable mask-like labium. The abdomen is very long, slender, and cylindrical; there are eleven uromeres, the eleventh being well represented, while the cercopoda are not jointed, but in the form of claspers.

3. *Ephemerina*.—In the small epicranium and the large male eyes the Ephemerina resemble the Odonata, though the rudimentary mouth-parts are in plan entirely unlike theirs. So also the prothorax is small and annular; but the subspherical concentrated thorax is remarkable for the large mesothorax and the small metathorax. Hence the hind wings are small and sometimes obsolete. The long slender abdomen has ten uromeres, and bears, besides the two long filamental multiarticulate cercopoda, a third median one.

The larvæ of the lower Odonata and of the Ephemeridæ closely approach in form those of the Perlidæ, showing that the three suborders here mentioned probably had a common ancestry, which can be theoretically traced to a form not remote from *Campodea*. By reason of the general resemblance of the larval forms of these three suborders it would be unadvisable to separate the Odonata and Ephemerina from the Platyptera, although when we consider the adult forms alone there would appear to be some grounds for such a division.

Order 4. NEUROPTERA.

The head is horizontal and somewhat flattened, except in the Trichoptera and Panorpidæ, where it is subspherical and vertical. The body shows a tendency to be round or cylindrical, the thorax being more or less spherical; but there is

great diversity in form from the Sialidæ to the Trichoptera. The mouth-parts are free, and the mandibles well developed, except in the Trichoptera, where the mandibles are nearly obsolete in form and functionless, thus suggesting or anticipating the Lepidoptera.

In the Neuroptera the ligula is entirely unlike that of any of the foregoing and lower groups. It is entire, forming a broad, flat, large rounded lobe; it is largest in *Myrmeleon*, *Ascalaphus*, and *Mantispa*, but smaller in *Corydalus*, where it is also narrower and indented on the front edge.

In *Panorpa* the ligula is minute, rudimentary; in the Trichoptera it is also minute and rudimentary.

The prothorax is usually (Planipennia) large, broad, and square, but is ring- or collar-like in the Trichoptera, being short and small, much as in Lepidoptera. Except in the Trichoptera, the meso- and metanotum are characterized by the large cordate præscutum; and in the Hemerobina the metascutum is partially or (in *Ascalaphus*) wholly cleft, the præscutum and scutellum meeting on the median line of the thorax.

In the Hemerobina and Sialidæ the metathorax is as large or nearly as large as the mesothorax, and the hind wings are as large as the anterior pair. The wings are not net-veined, the type of venation being entirely unlike that of the Orthoptera and Pseudoneureptera. The costal space is wide and well marked, and the transverse veinlets are few and far apart compared with the two orders just mentioned.

The abdomen is cylindrical; and there are nine or ten uromeres. The ovipositor is only developed in *Rhaphidia*, while the cercopoda are not developed. The metamorphosis is complete, as in the Lepidoptera &c., the pupa being entirely unlike the larva, and quiescent, often protected by a cocoon or case. The order may be divided into two suborders:—

1. *Planipennia* (Sialidæ, Hemerobiidæ, Panorpidæ).
2. *Trichoptera* (Phryganeidæ).

The following tabular view will in a degree express our views as to the classification of the orders of the hexapodous or winged insects:—

Superorders.	Orders.	Suborders.
Euglossata*	<div style="display: inline-block; vertical-align: middle;"> { Hymenoptera. Lepidoptera. . Diptera </div>	<div style="display: inline-block; vertical-align: middle;"> { Diptera (genuina). Aphaniptera. Pupipara. </div>
Elytrophora † ..	Coleoptera	<div style="display: inline-block; vertical-align: middle;"> { Coleoptera (genuina). Strepsiptera. </div>
Eurhynchota † ..	Hemiptera	<div style="display: inline-block; vertical-align: middle;"> { Homoptera. Heteroptera. Physapoda. Mallophaga. </div>
	Neuroptera	<div style="display: inline-block; vertical-align: middle;"> { Trichoptera. Planipennia. </div>
Phyloptera	<div style="display: inline-block; vertical-align: middle;"> { Pseudoneuroptera .. Orthoptera Dermatoptera. </div>	<div style="display: inline-block; vertical-align: middle;"> { Odonata. Ephemerina. Platyptera. </div>
Synaptera §	Thysanura	<div style="display: inline-block; vertical-align: middle;"> { Cinura. Symphyla. Collembola. </div>

XIX.—On Ure's "Millepore," Tabulipora (Cellepora) Ureii,
Flem. By JOHN YOUNG, F.G.S.

To the Editors of the 'Annals and Magazine of Natural History.'

GENTLEMEN,—In vol. xiii. (4th series) of the 'Annals' (for 1874) there is a short paper by R. Etheridge, Jun., entitled "Observations on *Chætetes tumidus*, Phill.," in which,

* We propose the name Euglossata for the highest insects, comprising those orders which, besides having the mouth-parts (either the first or second maxillæ or both) modified so as to sip, suck, or lap up liquid food, also have the body cylindrical and the thorax more or less spherical and concentrated.

† This term is proposed for the Coleoptera alone.

‡ This term is proposed for the Hemiptera, in all of which, except the Mallophaga and Physapoda (*Thrips*), the mouth-parts are united to form a sucking-beak.

§ This term is proposed for the Thysanuran apterous Hexapods, which are perhaps nearly the morphological equivalents of either of the three other superorders.

after referring to the several palæontologists who had noticed the structure of this organism, he describes some sections that he had prepared, and which are figured in plate xi. figs. 1 to 3. At page 195 he says, "This is probably the fossil figured by Ure in his 'History of Rutherglen and East Kilbride' (pl. xx fig. 1), and described by Fleming as *Cellepora Urei* (Brit. Animals, 1828, p. 533). If this is so, Ure was the first to figure *Chaetetes tumidus*; and it, like many of his figures, is very faithfully drawn."

Recently I have discovered what I believe to be an important internal character in the structure of the organism which Ure figured and described in 1793 as a species of "*Millepore*," and which will, I think, be the means of distinguishing it from Phillips's species, with which it has all along been confounded, from the great resemblance of the external characters in the two organisms.

This new character consists of a series of thin, perforated tabulæ that exist in the outer portion of the tubes of the larger corallites. The perforation or central opening in these tabulæ is of a roundly crescentic or reniform shape, and has a thickened edge or rim around its margin, its diameter being one third the width of the tubes. The concave edge of the opening in branching specimens is invariably turned towards the lower end of the branches; so that from this feature in the form of the perforation one is always able, in fragments, to say which was the lower or upper end of any branch in specimens where it could not be so determined from any of the other characters seen on the surface.

The tabulæ are numerous, their number varying from five to eight in each corallite, they being only about the diameter of the tubes apart, and are apparently confined to the outer portion, where the tubes bend from the nearly vertical position they occupy within the centre of the branches to open at right angles on the surface.

I first discovered this new character in thin incrusting specimens of the organism, which seems to be its first or earliest stage, and in which it is generally found attached to stems of crinoids, corals, and shells, in spot-like crusts that vary in size from one fourth of an inch to two or more inches in length. From this first thin incrusting stage the organism afterwards grew, in a branching manner, as described by Ure, until it attained a height, as seen in some specimens, of more than 3 inches. The branches, which are dichotomous and have rounded extremities, seldom exceed more than from 2 to 3 lines in diameter, their section varying from round to oval; but they are often found much crushed when imbedded in soft shale.

The external characters of Ure's "*Millepore*" vary somewhat in its several stages and in different specimens. In young examples the cells are bounded by thin walls, and the openings are polygonal. In older specimens the outer walls become much thickened, and the cell-openings are round or oval. In well-preserved specimens the outer surface of the walls is often seen to be minutely tuberculated or spinose, these tubercles, in polished sections, appearing as small pores in the walls; but they are not tabulated. Other, larger pores that exist in the walls at the angles between the larger cells, became filled with perforated tabulæ, like those in the tubes of the larger corallites, as the organism increased in diameter; but both of these sets of smaller pores disappear in the walls as sections of branches are ground from their surface to near the central axis, the walls there becoming thin and the cells polygonal, as seen in the earlier stage of the organism.

Ure's "*Millepore*" has maculæ on its external surface, and on one incrusting specimen that I have examined, these maculæ rise into distinct monticules. They are best seen on incrusting specimens of the organism, but are also to be found on many of the branching examples.

The maculæ are generally about 2 lines apart, and consist of spots in which are grouped a few very small cells, around which there are other cells that are somewhat larger in their openings than those of the normal size that fill in the spaces around the various maculæ.

The perforated tabulæ, which form the distinctive internal character of Ure's "*Millepore*," can be seen in nearly every specimen in which the structure has not been too much destroyed through mineralization of the organism. In the limestone shales of the East Kilbride district, where Ure obtained his specimens, it is abundant in several localities, but generally in fragments of branches. If any of these are rubbed down on a fine polishing-stone a little distance below the surface and at right angles to the mouths of the corallites, the perforated tabulæ are readily seen. Having prepared numerous specimens, both as transparent and opaque sections, for examination under the microscope, I find that those which show the tabulæ in the greatest numbers within the corallites are the opaque sections. This arises from the fact that the branches are often curved, and that the tabulæ do not all lie in the tubes at the same level, so that in flat sections only those few tabulæ that happen to be at the surface remain after grinding the specimens to transparency; while in opaque sections we not only see those perforated tabulæ that are at

the surface, but we also see many of those that are lying deeper in the tubes, shining up through the transparent calcite with which many of them are filled.

When specimens of the organism are ground so as to show the central axis of the branches in either cross or horizontal sections, the perforated tabulæ then show themselves in many of the tubes of the corallites as a series of small, thin, projecting points with a little rounded knob at their ends. This latter character is due to the thickened edge of the tabulæ, which, as formerly mentioned, forms a rim around the perforation. When the tabulæ in any of the tubes happen, however, to be cut in section on either side of the perforation, they are then seen to extend across the tubes in a complete manner; and this might deceive any one examining such a section as to their perforated character, or the existence of these little rounded knobs; but they are to be found in every well-preserved specimen in which the section cuts through the centre of the perforated tabulæ and not through either side.

Having stated this much regarding the peculiar internal structure of Ure's "Millepore," I shall not now enter into any lengthened comparison of its relation to those other forms with which it has been so long identified. In the Scottish lists of Carboniferous fossils it will be found catalogued under the several genera in which Phillips's species has been placed, viz. *Calamopora*, *Chaetetes*, and *Stenopora*, but with Phillips's specific name of *tumida* attached. Fleming's name *Cellepora Uriei* seems in a measure to have been lost sight of by palæontologists since his time, although the organism will be found under that name in Morris's 'Catalogue of British Fossils,' 1844, in the list of Polyzoa, as well as in the note by Mr. Etheridge, to which I have already referred.

The specimens examined by Mr. Etheridge as "probably" *Cellepora Uriei*, Flem., and which he identifies with *Chaetetes tumidus*, Phill., appear to me strongly suggestive, both from his figures and description, that it was really Ure's "Millepore" that he had under examination; but his sections either did not show or he had overlooked the existence of those perforated tabulæ that form the distinctive internal character of the organism.

Phillips's coral *Chaetetes tumidus*, with which Ure's "Millepore" has always been confounded from its external resemblance, has now been placed by Prof. A. Nicholson amongst the *Monticuliporæ* in his subgenus "*Heterotrypa*;" and in his most recent description of this species ('Palæozoic Corals,' *Monticulipora*, pp. 121, 122) he describes the tabulæ in the corallites as "horizontal" and "complete," not perforated

as in Ure's "Millepore." At page 103 Prof. Nicholson, in defining his subgenus "*Heterotrypa*," states that the corallum "consists of two sets of corallites of different sizes," and that "in all the corallites the tabulæ are complete, and the small tubes are more closely tabulate than the large ones." He, however, does not mention the existence of tabulæ in the small tubes in his description of the internal structure of *Heterotrypa tumida*, Phill., nor in its variety *H. miliaria*, Nich. Neither have I found evidence of the existence of tabulæ in the smaller tubes of Ure's coral. If we compare Ure's Millepore with *Stenopora*, Lonsd., in which genus both it and Phillips's species were formerly placed, we find that it differs in several important points of structure from *Stenopora*. The latter, according to Prof. Nicholson ('Tabulate Corals,' p. 168), has the tabulæ remote and complete, with annular thickenings in the walls of its tubes, and also has small mural pores in its walls, these being characters not found in Ure's coral, which, while it has certain resemblances in its external form, ornamentation, and the internal arrangement of its corallites to *Heterotrypa* and *Stenopora*, yet differs so distinctly from either genus in possessing perforated tabulæ, that neither of these genera, nor any other with which I am at present acquainted, will admit the form under description as at present these other genera are defined. This being the case, I propose to place, provisionally, Ure's "Millepore" in the *Monticulipora* group, under the new subgeneric name of *Tabulipora*, this name being descriptive of its beautiful and interesting internal structure, which, so far as at present known, distinguishes this organism from all its near allies; and at the same time I shall restore to it Fleming's name of *Urii*, after its original discoverer and describer, the Rev. David Ure, the earliest pioneer of Scottish palæontology.

I am, Gentlemen,

Faithfully yours,

JOHN YOUNG.

Hunterian Museum,
University of Glasgow,
August 8, 1883.

XX.—*Descriptions of some new Species of Lepidoptera.*

By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

THE species here described have for the most part recently been added to the collection of the British Museum.

RHOPALOCERA.

Lycænida.

1. *Miletus coelisparus*, sp. n.

♀. Above bright fulvous; primaries with moderately wide costal and external black borders, the former bisinuated: secondaries with a longitudinal subcostal black streak, which does not reach the apex, but almost joins an arched submarginal series of about six black spots: body brownish. Under surface paler, more yellow in tint, ornamented with reddish-orange markings edged with black and metallic sky-blue spots and dashes (most nearly as in *M. eucletus*, but of a more simple character) as follows:—all the wings with a discoidal stripe almost filling the cell, but with two deep notches out of it, so as to render its inferior edge zigzag; an irregular discal band, arched on the secondaries, and a macular arched submarginal band, that of the secondaries uniting towards the costa with the discal band; an interrupted blackish line at the base of the fringe; the secondaries also have three unequal subcostal spots above the cell and confluent with the discoidal stripe, and two interno-median spots uniting the centre of the discoidal stripe to the abdominal margin: body below whitish brown. Expanse of wings 34 millim.

Island of Nias.

2. *Myrina inopinata*, sp. n.

♂. General aspect above of *M. timon* of Africa; primaries above velvety black, interno-basal third, excepting at external border, greyish olivaceous, in certain lights bright emerald-green: secondaries with the basal half brown, greyish towards the abdominal margin, purplish in the cell, and with white costal border; a black-brown elliptical patch from the end of the cell to the centre of the radial interspaces; a large grey-brown sericeous patch clothed with long hairs, crossed by the subcostal nervure; externo-discal area emerald-green, external border narrowly black, tapering to a slender line from the third median; a black submarginal spot on the first median interspace, and a second at anal angle; a white spot between these two; anal angle, fringe, and tails white: body greyish brown; head white-spotted; thorax with greenish reflections. Under surface orange: primaries with the external two fifths sordid; internal third sericeous white, with a large central silver-grey patch: secondaries with the externo-anal and abdominal borders white; an abbreviated zigzag black line

from the abdominal margin to the third median branch; four small blackish spots beyond this line, two large black spots, one on the first median interspace and the other at anal angle, and a slender black marginal line; fringe and tails as above: body below white. Expanse of wings 46 millim.

Island of Nias.

HETEROCERA.

Chalcosiidæ.

3. *Epyrgis parvula*, sp. n.

Allied to *E. papilionaris* of Drury from China, but much smaller; white, with a tint of sulphur-yellow; all the veins much more slenderly black-bordered than in *E. papilionaris*, the white spots on the borders comparatively larger; the outer margins of all the wings shining cyaneous. Expanse of wings 45-50 millim.

Darjiling and Nicobars.

4. *Isbarta lactea*, sp. n.

Creamy white; primaries with the veins on the basal half blackish shot with emerald-green, on the apical half broadly smoky brown with green reflections; external border rather narrowly smoky brown; apical area between the veins somewhat greyish: secondaries with the apex smoky brown; veins beyond the middle and external border irrorated with blue-green scales: thorax cream-coloured, spotted with green-shot dusky spots: abdomen cupreous brown, with whitish posterior margins to the segments. Wings below whiter, the veins less broadly bordered; secondaries with the abdominal half chrome-yellow, external border of these wings rather broadly dark brown with dentate-sinuate inner edge; body below white. Expanse of wings 57 millim.

Java.

This species somewhat resembles *Milleria adakifa* in colouring.

5. *Pintia cyanea*, sp. n.

Primaries as in *P. metachloros* of Java, laky chocolate with broadly emerald-green veins and an ill-defined subapical whitish quadrifid band; secondaries brilliant glossy cobalt-blue; body above dark emerald-green. Under surface blackish, shot in the cell of primaries and on the median and submedian veins of secondaries with blue: primaries with a basicostal

tapering white streak; a second similar streak below the median vein; an oblique band of five white spots beyond the cell, and a small spot close to the external angle: secondaries with the cell and a belt of white markings commencing on the interno-median area with two streaks, above it with three gradually decreasing spots, and terminating with a larger subapical spot. Body below white, the sides of the pectus and the legs varied with dark green. Expanse of wings 45 millim.

Sumatra.

Nyctemeridæ.

6. *Leptosoma melaneura*, sp. n.

Nearly allied to *L. coleta* of Cramer (which we have from Ceram, Malacca, and Java), but differing in the narrow black borders to its wings, the narrower irregular band across the primaries, and in the black colouring of the veins on all the wings. Expanse of wings 50 millim.

Island of Nias.

XXI.—Description of new Species of Reptiles and Batrachians in the British Museum. By G. A. BOULENGER.

(Plate V.)

Lipinia anolis, sp. n.

Snout pointed, as long as the distance between the eye and the ear-opening. Latter narrow, its anterior border with a feeble denticulation formed by four scales. Rostral large, truncated behind. Internasal pentagonal, about as large as one of the prefrontals. Latter in contact mesially, the suture measuring less than half their greatest length. Frontal four-sided, much longer than broad, the anterior sides forming an open angle, the posterior a very acute angle, the point being slightly rounded off. The suture between the frontoparietals measures at least half the length of the frontal. Interparietal of the same shape as the frontal, but smaller. Five supraorbitals, the anterior largest, but much shorter than the four others together; the space between the supraorbital regions considerably wider than in *Lipinia pulchella*. Nasal four-sided, pierced in the centre. Three loreals. Supero-labials eight or nine, sixth or seventh entering the orbit.

Three or four large shields on the temple. Mental large, truncate behind. Seven or eight lower labials, very narrow, in contact with five or six very large chin-shields, the anterior single, the others paired. Behind the parietals four or five pairs of large transversely dilated cervical scales. The scales of the body largest on the back, smallest on the sides; those of the two median dorsal series much the largest, twice as broad as long; sixty-five scales on the dorsal line, counted from the parietal shields to the base of the tail; thirty-eight series of scales round the body. Two large preanal scales. The fore limb carried forward does not reach the tip of the snout. Basal part of the fingers and toes distinctly dilated, with large transverse curved lamellæ; sixteen to eighteen lamellæ under the dilated part of the fourth toe, and seven under the compressed distal joint of same. Fourth digit slightly longer than fifth. The length of the tibia equals the distance between the tip of the snout and the pupil. The scales on the humerus and femur smaller than those on the forearm and leg. Uniform light olive-brown above, white beneath; head olive above.

	millim.
Total length	135
From snout to vent	57
Head (to ear-opening)	14
Width of head	8.5
From ear-opening to fore limb	8
Fore limb	21
Hind limb	24
Tail	78

Several specimens were collected in the Solomon Islands (Treasury and Santa Anna) by H. B. Guppy, Esq., during the expedition of H.M.S. 'Lark.'

Rhacophorus lateralis, sp. n.

Vomerine teeth in two small oblique series between the choanæ. Snout rounded; canthus rostralis distinct; loreal region slightly concave; nostril nearer the tip of the snout than the eye; interorbital space broader than the upper eyelid; tympanum half the diameter of the eye. The three outer fingers nearly entirely webbed; toes nearly entirely webbed; disks of fingers and toes smaller than the tympanum; subarticular tubercles not very prominent; a rather indistinct inner metatarsal tubercle. The hind limb being carried forwards along the body, the tibio-tarsal articulation reaches the tip of the snout. Skin smooth, granular on the belly and under the thighs; a fold of the skin bordering the fore limb anteriorly. Purplish above, white beneath; head and back

with dark dots ; coloured parts of limbs with dark cross lines ; a white streak on each side, from the nostril along the outer edge of the upper eyelid to the groin ; arm, the three inner fingers, and the four inner toes not coloured. From snout to vent 31 millim.

A single young specimen from Malabar, collected by Col. Beddome*.

Rappia Burtonii, sp. n.

* Snout rounded, as long as the orbital diameter ; tympanum hidden. Fingers half webbed ; toes three-fourths webbed. The hind limb being carried forwards along the body, the tibio-tarsal articulation reaches between the eye and the tip of the snout. Skin smooth, granular on the belly ; no fold across the chest. Upper surfaces and throat purplish grey ; hands and feet (the disks excepted), sides and lower surface of hind limbs, a streak from nostril to eye, and marblings on the side of the body and behind the eye carmine ; belly flesh-coloured ; throat and belly with blackish spots. From snout to vent 27 millim.

Allied to *R. lagoensis*, Gthr. ; but in that species the web reaches the disks of all the toes except the fourth, and the head is comparatively rather broader. In coloration the two species are extremely different.

A single female specimen was collected on the Ancover river, Gold Coast, and presented to the British Museum by Major Burton and Captain Cameron.

Bufo Andersonii, sp. n.

Crown without bony ridges ; snout short, blunt ; inter-orbital space flat, a little broader than the upper eyelid ; tympanum very distinct, round, two thirds the diameter of the eye. First finger extending as far as or slightly beyond second ; toes two-thirds or half webbed, with simple subarticular tubercles ; two moderate metatarsal tubercles ; a tarsal fold. The hind limb being carried forwards along the body, the tarso-metatarsal articulation reaches between the shoulder and the eye. Upper parts with irregular flat warts ; parotoids large, elliptic, flat ; brownish or olive-grey above, spotted or marbled with darker ; beneath immaculate. Male with a subgular vocal sac. Size of *B. viridis*.

* Mentioning Colonel Beddome's important discoveries in Malabar, I must rectify a misprint which has occurred in the diagnosis of *Nannobatrachus Beddomei* in the 'Catalogue of Batrachia Ecaudata,' p. 470. For "interorbital space narrower than the upper eyelid," read "upper eyelid narrower than the interorbital space."

This toad has been accurately characterized by Anderson, P. Z. S. 1871, p. 203, but erroneously referred to "*Bufo pantherinus*" of authors. His specimens are from the Agra district, where it is said to be common. There are three specimens in the British Museum, all three presented by W. T. Blanford, Esq.; two half-grown from Ajmere, collected by Major St. John, and an adult female without locality. Other specimens, male and female, from Tatta, are in the Indian division at the Fisheries Exhibition, where they are put down as *Bufo melanostictus*.

Hyla glandulosa, sp. n.

Tongue circular, slightly nicked, and free behind. Vomerine teeth in two small oblique groups between the choanæ. Head moderate, a little broader than long; snout rounded, as long as the diameter of the orbit; canthus rostralis distinct; loreal region slightly concave; interorbital space a little broader than the upper eyelid; tympanum small, indistinct. Fingers large, distinctly webbed at the base; toes two-thirds webbed; disks well developed; subarticular tubercles moderate; no tarsal fold. The hind limb being carried forwards along the body, the tibio-tarsal articulation reaches the anterior corner of the eye. Upper surfaces covered with very small smooth warts; lower surfaces granulate. Green above, white beneath; a blackish streak from the nostril to the shoulder, passing through the eye, flanks with blackish variegation. From snout to vent 35 millim.

Two female specimens from Guatemala, presented by F. D. Godman, Esq.

Hyla macrops, sp. n.

Tongue oval, slightly nicked, and slightly free behind. Vomerine teeth in two groups between the choanæ; latter large. Head large, depressed, as long as broad; snout rounded, as long as the diameter of the orbit; canthus rostralis distinct; loreal region very oblique, concave; eye very large; interorbital space as broad as the upper eyelid; tympanum distinct, half the diameter of the eye. Fingers one-fourth webbed; no distinct rudiment of pollex; toes three-fourths webbed; disks of fingers and toes rather small, much smaller than the tympanum; subarticular tubercles small; two metatarsal tubercles, outer very small; no tarsal fold. The hind limb being carried forwards along the body, the tibio-tarsal articulation nearly reaches the tip of the snout. Skin smooth above, granulate beneath. Purplish brown above, white beneath, unspotted. Bones green. Male with an internal subgular

vocal sac and brown rugosities on the inner side of the first finger. From snout to vent 38 millim.

One male specimen, from Treasury Island, Solomon group, collected by H. B. Guppy, Esq., H.M.S. 'Lark.'

Hynobius lichenatus, sp. n. (Pl. V. fig. 1.)

In the shape of the series of palatine teeth intermediate between *Hynobius* and *Onychodactylus*. These series form a zigzag row, the central or posterior angle not extending posteriorly beyond the extremity of the outer branches. Head large, depressed, as broad as long; snout short, rounded; eyes rather large, prominent; no labial lobes. Body short, a little more than thrice the length of the head; the distance from snout to gular fold contained a little more than twice and a half in the distance from latter to cloaca. Limbs moderate; when laid against the body the fingers cross the toes. Fingers and toes moderate, depressed; fifth toe rudimentary, as in *Hynobius peropus*. Tail about as long as head and body, strongly compressed and keeled superiorly and inferiorly, ending in a blunt point. Skin smooth, shining; eleven costal grooves; a median dorsal groove; parotoids rather indistinct, porous; gular fold strongly marked; a distinct groove behind the angle of the jaws. Brown above, lighter beneath, with lichen-like greyish variegation; whitish dots on the sides of the body.

	millim.
Total length	74
From snout to cloaca	38
Head	9
Width of head	8.5
Fore limb	13
Hind limb	14
Tail	36

A single specimen from Awomori, Japan, presented to the British Museum by George Lewis, Esq.

Spelerpes peruvianus, sp. n. (Pl. V. fig. 2.)

Palatine teeth in two arched series, extending externally beyond choanæ, separated from parasphenoid teeth; latter forming a pyramid-shaped patch. Head moderate, longer than broad; snout truncate, with a swelling below each nostril; eye rather large. Body about three times as long as the distance between the tip of the snout and the gular fold. Limbs weak, not meeting when adpressed; fingers and toes entirely united; no carpal or tarsal tubercles. Tail slightly compressed, a little shorter than head and body. Skin smooth; no parotoids; gular fold strong; costal grooves twelve, very indistinct; light brownish above, with ill-defined brown

longitudinal lines; a triangular dark spot, base forward, on the crown; lower surfaces and limbs brown, with slight lighter variegations.

	millim.
Total length	75
From snout to cloaca	39
Head	7.5
Width of head	6
Fore limb	8.5
Hind limb	9
Tail	36

A female specimen was collected at Moyobamba by Mr. A. H. Roff.

This is the second species of Tailed Batrachians discovered south of the Equator. It resembles *S. rufescens*, Cope, from Central America, in most of its characters and in coloration; but that species has the body less elongate, and the palatine teeth do not extend outwards beyond the choanæ.

CRYPTOPSOPHIS, g. n. *Cæciliidarum*.

Squamosals in contact with parietals. A single series of teeth in the lower jaw. Tentacle globular, situated in front of the eye. Cycloid scales imbedded in the skin.

Cryptopsophis multiplicatus, sp. n.

Teeth rather small, subequal in each jaw, the mandibulars larger than the maxillaries, the palatines very small; number of teeth on one side—maxillary nineteen, mandibulars sixteen, palatines twenty. Snout rounded, prominent, as long as the distance between the eyes; latter very indistinct; tentacle below and in front of the eye, three times nearer the latter than the nostril. Body moderately elongate, rather depressed; 220 circular folds, the 22 anterior (primary) and the 25 posterior complete, the others alternately complete (primary folds) and interrupted on the ventral side (secondary folds). Tail indistinct, rounded. Olive-brown above, yellowish inferiorly. Total length 310 millim., greatest diameter of body 13 millim.

A single specimen, from the Seychelles, is in the British Museum.

This new genus agrees in every particular with *Dermophis*, except in the absence of a second row of mandibular teeth, a character which occurs in two other genera only, viz. *Siphonops* and *Scolecomorphus*. This being the third new genus of Apoda discovered since the publication of the 'Catalogue of Batrachia Caudata and Apoda,' I add a synopsis of the genera known at present:—

I. Cycloid scales imbedded in the skin.

A. Eyes distinct or concealed under the skin.

1. Two series of teeth in the lower jaw.

a. Squamosal and parietal bones in contact.

- | | |
|---|-------------------------------|
| Tentacle conical, exsertile | 1. <i>Ichthyophis</i> , Fitz. |
| Tentacle flap-like, below the nostril | 4. <i>Cæcilia</i> , L. |
| Tentacle flap-like, posterior to the nostril .. | 5. <i>Hypogeophis</i> , Ptrs. |
| Tentacle globular | 6. <i>Dermophis</i> , Ptrs. |

b. Squamosals separated from parietals.

- | | |
|--|-------------------------------|
| Tentacle flap-like, close to the eye | 2. <i>Epicrionops</i> , Blgr. |
| Tentacle conical, exsertile, below the nostril . | 3. <i>Urotyphlus</i> , Ptrs. |

2. A single series of teeth in the lower jaw.

- | | |
|-------------------------|---------------------------------|
| Tentacle globular | 7. <i>Cryptopsophis</i> , Blgr. |
|-------------------------|---------------------------------|

B. Eyes below the cranial bones.

- | | |
|---|-----------------------------|
| Tentacle globular, nearer the commissure of the jaws than the nostril | 8. <i>Gymnopsis</i> , Ptrs. |
|---|-----------------------------|

- | | |
|--|---------------------------|
| Tentacle globular, nearer the nostril than the commissure of the jaw | 9. <i>Herpele</i> , Ptrs. |
|--|---------------------------|

II. No scales.

A. Eyes below the cranial bones.

1. Two series of teeth in the lower jaw; squamosals in contact with parietals; tentacle globular

10. *Gegenophis*, Ptrs.

2. A single series of mandibular teeth; squamosals separated from parietals; tentacle globular

11. *Scolecomorphus*, Blgr.

B. Eyes distinct or concealed under the skin.

1. A single series of teeth in the lower jaw; squamosals in contact with parietals; tentacle flap-like

12. *Siphonops*, Wagl.

2. Two series of teeth in the lower jaw; tentacle flap-like.

- | | |
|---|---------------------------------|
| Parietals and squamosals in contact | 13. <i>Typhlonectes</i> , Ptrs. |
|---|---------------------------------|

- | | |
|---|----------------------------------|
| Parietals separated from squamosals | 14. <i>Chthonerpeton</i> , Ptrs. |
|---|----------------------------------|

XXII.—On the 'Classification of the Coleoptera of North America,' by Dr. J. L. LeConte and Dr. G. H. Horn (Washington: 1883). By the Rev. A. MATTHEWS.

EUROPEAN entomologists are often impressed with the idea that their scientific brethren on the other side of the Atlantic are so embarrassed with the riches of their own fauna that they are comparatively unacquainted with the productions of the eastern hemisphere. But such a notion indicates a very imperfect comprehension of American intellect and American resources. No reason can be given to prove that a species

inhabiting any part of the Old World should not be as well known in Philadelphia as in London, Paris, or Berlin; and much less is there any reason to suppose that American entomologists are not, at the very least, as well able to appreciate its affinities as the most erudite of their European contemporaries. In some respects, indeed, they possess superior advantages, inasmuch as they have begun the science, as it were, *de novo*, unfettered by time-honoured traditions, and unbiassed by favourite, though antiquated, systems founded upon partial and often imperfect knowledge—systems which, although they fulfilled the conditions of their own age, are inadequate to meet the requirements of a time like the present, when a vastly extended field of observation, and a much more numerous band of students, assisted by greatly improved means of investigation, are continually enlarging our knowledge by the discovery of fresh links and synthetic forms disclosing correlative affinities between groups whose connexion had previously been unsuspected. In such a state of things a revision of our systematic classification was imperatively called for; and this work has been inaugurated by the recent publication of the 'Classification of the Coleoptera of North America,' by Dr. LeConte and Dr. Horn.

Although by its title this great work professes to deal with the fauna of merely one half of the western hemisphere, the comprehensive lines on which it has been constructed will include (with, it may be, trifling modifications) the Coleoptera of both sides of the world. Indeed it is evident from the work itself that its authors had this object in view, since every family at present contained in the order is mentioned, and its proper position in the system assigned to each. On this account many subtribes and subgroups are made which at first sight seem superfluous, represented as they are often by a single genus, and sometimes by a single species, in the North-American fauna; but the same subdivisions occasionally comprise an extensive series of insects in other quarters of the world.

The "Table of Contents" (pp. v, vi) gives a compendious view both of the completeness of this great work and of the labour expended on its construction. This is followed by an elaborate "Introduction" (pp. vii-xxxviii), which might well be termed an Introduction to the entire science of entomology. Having given a tabular view of all orders of insects, the Authors restrict their labours to the Coleoptera alone; and at this point commence their real work with a complete and lucid definitive analysis of the whole external skeleton of a beetle, illustrated by numerous and well-executed woodcuts of the

entire underside, and of the various modifications of the antennæ, tarsi, &c. which occur in the order.

The basis of operations being thus defined, they proceed with the actual classification by dividing the whole order into two primary divisions, viz. "*Coleoptera genuina*" and "*Rhynchophora*."

The former of these divisions, for which the term "*Stomatophora*" would have been more consonant, and also indicative of the normal position of the mouth, is then divided into two subdivisions, termed respectively "*Isomera*" and "*Heteromera*;" and the *Isomera* are separated into five series, viz. "*Adephaga*," "*Clavicornia*," "*Serricornia*," "*Lamellicornia*," and "*Phytophaga*."

It appears to me that the arrangement of the *Isomera* would be much improved by placing the *Lamellicornia* at the commencement of the subdivision, a change long ago suggested by Dr. Burmeister and Mr. Crotch, and even alluded to in the work before us. While the other series are more or less intimately connected with each other, the *Lamellicornia* alone are isolated and distinct from all. The authors of this classification, in order to bring into contact the closely allied *Clavicornia* and *Serricornia*, have removed the *Lamellicornia* from their ancient position between those series, and have placed them next in succession to the *Serricornia*, and immediately preceding the *Phytophaga*. But I cannot perceive that any improvement has been effected by this change. The *Lamellicornia* are as much, if not more, out of place between the *Serricornia* and the *Longicorn* group of the *Phytophaga*, as they were in their previous position. To place the *Lamellicornia* at the commencement of the order seems to be the only way to obviate this difficulty of classification.

In support of such an arrangement many collateral arguments may be adduced. As in the *Mammalia* man is allowed to take the lead as the most highly organized and perfect of the class, so in the *Coleoptera*, by a parity of reasoning, the first place should be assigned to the *Lamellicornia*, since they are the most highly organized and the most perfectly developed of that order. Again, among *Coleoptera* the *Lamellicornia* may be regarded as the representatives of the existing period of the universe, specially adapted to the present conditions of this planet; while, on the other hand, the *Rhynchophora*, exhibiting the most primæval and original form, and possessing the most rudimentary and often defective anatomy, are probably, according to Dr. LeConte's theory, the most ancient series of the whole order.

The *Lamellicornia* and the *Rhynchophora* should therefore

on this ground, either in an ascending or descending scale, occupy the two extremes of the entire order. In his 'Rhynchophora of America,' published at Philadelphia in 1876, Dr. LeConte has discussed this matter at some length, and, choosing the descending scale, has placed the Rhynchophora at the end of the Coleoptera.

If his views on this point are correct, as I believe them to be, it will naturally follow that the Lamellicornia should be placed first. Such an arrangement would at once rectify the confusion caused by the interpolation of the Lamellicornia between series unconnected with them, but closely allied to each other; harmony would be effected by the elimination of the element of discoid, and the Lamellicornia would occupy the position for which by high development and homogeneity among themselves they are preeminently qualified.

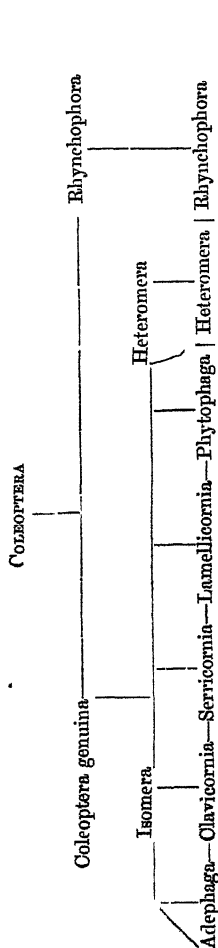
But to return to the work before us; the American authors have named the last series of the Isomera "Phytophaga," and have included in that series the whole of the properly Tetramerous Coleoptera. This arrangement seems open to objection on account of the heterogeneous assemblage of genera thus brought together. The authors themselves appear conscious of this, and justify the amalgamation on the ground that no definitive characters can be assigned to warrant their separation. But though anatomical differences among these families may not be sufficient or sufficiently persistent to form an intelligible tabulation, yet the general appearance or facies of almost every species is obvious enough to determine its proper position without much difficulty. On the whole it would, I think, be preferable to retain the serial separation of Longicornia and Monilicornia, of which the former in their larval condition as a rule feed on wood, and the latter on foliage. These alterations would tend to improve the continuity of its various series, and render the Isomeric complex more harmonious than it has hitherto been.

Having disposed of the Isomera, our authors place the Heteromera next in succession. This arrangement is a manifest improvement upon previous systems; for it is absurd to break the line of the Isomera by interposing a group whose very name indicates antagonism; and besides this the Heteromera, by their varied and mimetic forms, seem intended for a natural epitome of all the Isomeric series.

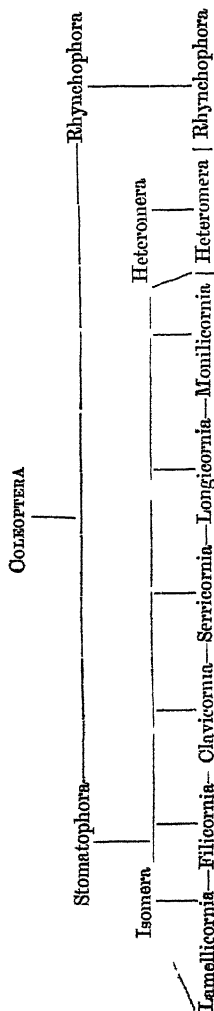
The Rhynchophora, as a suborder, conclude the whole system; nor could they hold any other position without breaking through the anatomical relations which prevail throughout the other groups. But this question has been argued at length by Dr. LeConte many years ago, and need not be noticed now.

The following schemes will show both the descent of the various series as proposed by Dr. LeConte and Dr. Horn and also the alterations which I have suggested:—

Scheme of the Arrangement of Coleoptera as proposed by Dr. LeConte and Dr. Horn.



Scheme showing the Alterations suggested in this Essay.



From this point the authors proceed to give a detailed account of the various families, tribes, subtribes, and genera

of which each series is composed, illustrating each separate division with a synoptic table of its contents and copious remarks on its diagnostic characters. In all these matters their views are of course open to discussion; whether a certain genus does or does not belong to a certain tribe is a matter of opinion, and can only be decided when its anatomical affinities have been thoroughly investigated. But these minutiae are comparatively of small importance, and do not in any way affect the main lines of the system.

Such are the chief features of this great work, extending through 605 royal 8vo pages. The basis on which the system is founded, that of the entire external skeleton, is more consonant with the general scope of systematic arrangement in the higher classes of the animal kingdom, and much less liable to error than the tarsal or any other system which rests upon special organs alone. It is a system which only requires careful study to ensure approval; it has conferred a lasting benefit on science and much honour upon its authors. To assert that it is perfect would be to assert more than man can accomplish. It is at the least a long step in the right direction, and opens a path which must lead to further important results.

But the rôle of Lord Lytton's "Randall Leslie" and "John Burley" will continue to be repeated till the end of time, and plagiarists will doubtless reproduce the views of the American naturalists with some trifling modifications as their own. In the name of common honesty let those who henceforth build upon the lines here laid down have at least sufficient candour to acknowledge their obligations—a candour which recent events have proved to be rare.

XXIII.—*Notes on some Fossil Plants from Northern China.*
By J. S. NEWBERRY*.

MR. ARNOLD HAGUE recently placed in my hands a small collection of fossil plants brought by him from China. They proved to be interesting; and, with his permission, I present briefly the results of my examination of them.

The circumstances under which they were found, so far as known, are given in the subjoined notes of Mr. Hague which accompanied them:—

"This collection of plants came from the coal-basin of the

* From the 'American Journal of Science,' Aug. 1883, pp. 123-127.

Pinkshu-hoo, in the southern peninsula of Mantchuria, on the east side of the Gulf of Liantung, and about one hundred miles north-east of the open port of Niu-chwang. I am told that at times there are over 1200 Chinamen engaged in the district in mining and transporting coal. This coal-field has long been known to foreigners through the Chinese as a possible source of workable coal. As long ago as 1863 Prof. Pumpelly suggested that the Liantung coals should be examined by American or European experts before opening the mines at Chaitang, which he had personally visited and reported upon favourably.

"So far as I know, no geologist has visited the district except Baron v. Richthofen, who regarded the formation as of Palæozoic age, although, I believe, he found no fossils.

"From my own observations while travelling through the provinces of Chihite and Shansi, and from various sources of information, I believe by far the greater part of the coal-basins of North China are of Palæozoic age, although the well-known districts west and north-west of Peking have been shown to be of Mesozoic age.

"The estimates of the great area and value of the coal and iron deposits of North China, which have been made by Prof. Pumpelly and Baron Richthofen, are, I think, by no means unwarranted.

"There can be no question but that the coal and iron of China will prove to be of immense value in the material development of the country so soon as she decides to adopt railways and foreign engineering methods."

On unpacking the collection I discovered that the plants were of Carboniferous age, and that most of them belonged to species common in the rocks of Europe and North America.

Of the ten species which can be distinguished, one is a *Pecopteris* too imperfect for determination (probably *P. unita*, Brgt.), and two others, a *Lonchopteris* and an *Archæopteris*, present slight differences from their closely-allied representatives in Europe and America. The other seven are undistinguishable from what may be considered as the most characteristic plants of our Coal-measures.

The complete list of species is as follows :—

- Annularia longifolia*, Brgt.
- Sphenophyllum oblongifolium*, Germar.
- Calamites Suckowii*, Brgt.
- Cordaites borassifolius*, Ung.
- Lepidodendron obovatum*, Sternb.

Sigillaria Brardii, Brgt.

Pecopteris cyathea, Brgt.

Pecopteris unita?, Brgt.

Archæopteris, n. sp.?

Lonchopteris, n. sp.?

The *Archæopteris* indicates that the coal with which these plants are associated belongs near the base of the Coal-measures, as this genus does not rise above that horizon.

The species of *Lonchopteris* and *Archæopteris* are best represented in the collection; and the former is very well shown. In general aspect it is not unlike the figures given by Brongniart of his *L. rugosa* (Vég. Foss. p. 368, tab. 131. figs. 1, 2, 3); but the pinnules are smaller, and the reticulation much more open. In the latter respect it is more like *L. Baurii*, Andr., *L. Eschweilerianus*, Andr., and *L. conjugata*, Goepp., sp. (*Neuropteris conjugata*, Goepp.); but it has narrower, more pointed and curved pinnules than either.

Should a larger number of specimens show that these are constant characters, it will be necessary to regard this as a new species, which may be fittingly named after Mr. Hague, *Lonchopteris Hagueana*. The *Archæopteris* mentioned is a very graceful and well-marked species of the genus, having obovate or spatulate pinnules, of which the upper extremities are often crenulate or fimbriate. It is less robust than the type forms of *A. hibernica*, Forbes, sp.; and the pinnules are more symmetrical. It is about the size of *A. Jacksoni*, Dwn., but has less crowded, more elongate, and more regularly ovate or spatulate pinnules. The nerves are fine, forked only near the base, simple and subparallel above. Possibly this may be, like several described species of *Archæopteris*, only a variety of *A. hibernica*; but the characters mentioned seem to separate it from any known form, and I would suggest for it the name *Archæopteris spatulata*.

The first fossil plants brought from China were collected by Prof. Pumpelly, and were described by the writer in the 'Smithsonian Contributions' of 1866. These included two new ferns, *Sphenopteris orientalis*, N., and *Hymenophyllites tenellus*, N., *Pecopteris whitbyensis*, found in the Lias and Upper Trias of Europe, *Podozamites lanceolatus*, a Liassic plant of the old world, and *P. Emmonsii*, which occurs in North Carolina, all of which seem to represent the Upper Trias or Lower Lias*. Subsequently (in 1868) M. Ad. Brongniart ex-

* My paper on the fossil plants collected by Prof. Pumpelly has been reviewed by Heer ('Juraflora Ostsiбириens,' p. 17) and Schenk (Richt-hofen's 'China,' vol. iv. p. 264), with some suggestions in regard to their generic and specific relations, which would hardly have been made

amined a collection of plants obtained from Southern Shansi, and gave a list of them in the Bull. de la Soc. Géol. de France, 3rd series, vol. ii. p. 408. They included some of the species collected by Pumpelly, and were considered by M. Brongniart to represent the Upper Trias and Lower Jura. More recently Baron v. Richthofen obtained fossil plants from various parts of China; and these have been described by A. Schenk in vol. iv. of Richthofen's 'China.' They represent two distinct horizons—one Carboniferous, and the other Mesozoic. The former were found in the districts of Shansi and Hunan. Here were obtained *Pecopteris cyathea*, *P. unita*, *Annularia longifolia*, Brgt., *A. maxima*, Schenk, *Sphenophyllum emarginatum*, Brgt., *S. Schlotheimii*, Brgt., *Calamites gigas*, Brgt., &c. Elsewhere in the provinces of Shansi and Tshili, Richthofen obtained a group of Mesozoic plants, among which M. Schenk recognized *Pecopteris whitbyensis*, *Podozumites lanceolatus*, and other species which led him to refer the strata containing them to the Brown Jura.

It is known to most geologists that the extensive coal-basins of India, from which fossil plants have been described by Oldham and Morris and Dr. Feistmantel, are all of Mesozoic age. The same is true of the coals of Tonking, Cochin China, from which a considerable number of fossil plants have been obtained by the French expeditions and described by M. R. Zeiler in the 'Annales des Mines,' October 1882.

It would seem proven, therefore, that the coal-basins of China (in which the coal is very largely converted into anthracite by local metamorphism) belong to two great geological systems—one, as indicated by the plants collected by Baron Richthofen and Mr. Hague, the equivalent of the Coal-meas-

had these distinguished palaeontologists had access to the specimens on which I based my conclusions. Having reexamined these fossils, I take occasion to offer here a few additional notes upon them.

Sphenopteris orientalis certainly belongs to the same genus with the ferns now called *Thyrsopteris Murrayana* and *Th. Muakana*, Heer, the latter being specifically hardly different from it. *Hymenophyllites tenellus*, N., has finely dissected pinnules, and is certainly distinct. My *Podozumites lanceolatus* is that plant, and not a *Phanicropsis*, as suggested by Heer. This is shown by its nervation, and by the fact that the pinnules are pinnately set on a rachis, and are not fasciculate as in *Phanicropsis*. *Taxites spatulatus*, N., is the leaf of a conifer, and not of a cycad, as inferred by Heer. It has but a single nerve, the median, which is strong and traverses its entire length, and has a wedge-shaped base terminating in a short twisted petiole. The publication of Heer's important paper on the Jura flora of Eastern Siberia has given significance to certain specimens in Pumpelly's collection, and has enabled me to add to the list of species *Baiera angustiloba*, Heer (very near to *B. Munsteriana*), *Phanicropsis longifolia*, Heer, and *Czekanowskia rigida*, Heer.

tures (and probably the entire range of the Coal-measures of Europe and America); the latter not yet capable of so definite classification, but probably referable to both the Rhætic and Lias.

The fossil plants brought by Mr. Hague from China, representing as they do not only the characteristic genera of the Coal-measures in Europe and America, but identical or closely allied *species*, cannot fail to interest both geologists and botanists:—the first, by the confirmation they afford of the classification adopted for the stratified rocks, based on the fossils they contain; the latter, from the evidence they furnish of the practical identity of the acrogenous flora of the Coal period over so large a portion of the earth's surface, and the remarkable persistence which specific characters exhibit in the wide range of migration and the incalculable lapse of time through which the dispersion was effected.

Since none of the higher plants were in existence upon the earth's surface during the Carboniferous age, wherever a terrestrial flora prevailed it could only be composed of acrogens and gymnosperms; but how it happens that within these limits there was so little diversity is incomprehensible. During the Coal-measure epoch the same genera, and to a large degree the same species, seem to have lived in North America, Europe, Brazil, and China.

No one who has any acquaintance with fossil plants would fail to recognize at once most of the species in the collection brought by Mr. Hague; but if shown seven out of the ten he could not say whether they came from America, Europe, or Asia. And yet in the interval between the deposition of the Coal-measures and the Triassic rocks the whole flora of the globe was revolutionized. Before the Bunter was laid down *Lepidodendron*, *Sigillaria*, *Annularia*, *Sphenophyllum*, *Cordaites*, and indeed all the characteristic forms of the coal flora had disappeared. The Cycads in great variety, true Equiseta, and peculiar genera of Conifers and Ferns gave new aspects to nature, and this again over the whole world. From the desert of Atacama, from Sonora, New Mexico, North Carolina, Europe, India, and China we obtain the remains of the unmistakable Mesozoic flora with species which are common to all these widely separated localities.

Hence we are safe in fixing by fossil plants the geological horizon of the Mesozoic coal-basins of China; but the identity of species in the Mesozoic flora, though surprising, is not quite so marked as in that of the Carboniferous age.

In the Middle Cretaceous came another great revolution, and the angiosperms succeeded the gymnosperms so rapidly

that the earth was covered with oaks, magnolias, willows, &c. before the Tertiary began. Gradually we are gathering the details of this wonderful history, and ultimately we shall be able to report the *facts* with a good degree of fulness; but the causes which inspired the revolutions that have taken place in plant life, and the processes by which these great changes have been effected, seem to be as inscrutable as ever.

XXIV.—*On the Structure and Affinities of the Genus Tristychius, Agass.* By THOMAS STOCK, Natural-History Department, Museum of Science and Art, Edinburgh *.

[Plate VII.]

Tristychius fimbriatus, Stock. (Pl. VII. figs. 1 and 1 a.)

This spine I owe to the kindness of those promising young naturalists Messrs. Kinnear and Anderson, who discovered it in the Carboniferous Limestone series at Gilmerton, near Edinburgh. It appears to be hitherto undescribed.

Description.—It is distinctly sigmoidal in shape; but the curvature presents an exaggerated appearance through fracture. The restoration (Pl. VII. fig. 1 a) gives a more correct idea of its original shape. The direction of the curve in the distal region is peculiar, and, indeed, almost without a parallel in Selachian acanthoid remains. Nevertheless I attach very slight importance to it as a systematic character. It is possibly due to disease, of which there is some evidence in certain pustular appearances seen near the pointed extremity of the spine (Pl. VII. fig. 1). It is $1\frac{2}{3}$ inch in length, and $1\frac{1}{2}$ line in greatest width. Its surface is smooth; but a shallow and wide groove occupies a nearly central position along the middle third of the spine. It is difficult to say how far such grooves, which occur rather frequently in the spines of various genera and species, are normal, or whether they arise from the falling-in of the walls of the spine as the soft internal part decays. In the case of *Pleuracanthus*, in which this middle groove is often visible, the appearance is due to decay in all the cases that have come under my notice. But in the example under consideration I am inclined to think that the appearance is normal, as the walls are apparently thick and the

* Communicated by the Author, having been read to the Edinburgh Geological Society, March 15, 1883.

pulp-cavity small; its value as a specific character must, however, be accepted with considerable reserve.

The seven denticles are confined to the distal fourth of the spine, and form a rather crowded series; they slightly increase in length proximally; and their bases are *fused* into the walls of the spine. The second row (if existent) is concealed in the matrix. The inserted portion of the spine is not preserved.

Affinities.—Giebel * figures a spine which may possibly come near the one just described. In the text he refers it to *Styracodus acutus*, a species and genus founded by himself for the reception of a very *Otenoptychius*-like fossil (a resemblance he was quite aware of himself). In the plate, however, it appears as *Hybodus*, along with other forms referred to the same genus. The reference, however, is clearly due to carelessness in naming the figures; for it is evident from the text that Giebel had no conception that the spine could possibly be related to the remains that he figures on the same plate as belonging to *Hybodus*. Nevertheless there is some ground for believing (unless all faith is refused to his figures) that the spine which he referred to *Hybodus* is nothing but *Pleuracanthus* †, and therefore unconnected with the remains in question, but that the spine named *Styracodus acutus* may really belong to them. This spine is unfortunately broken off just at the point where the denticles would commence if it be, as I surmise, a species of *Tristychius*; but in other respects it conforms closely enough to the genus. From his figures 5 and 7 it is evident that some tolerably undisturbed Selachian fragments had been discovered; for we see a number of teeth associated with cuticular appendages upon the same slab. Separate figures of the teeth are given ‡, from which it is quite possible to gather that they bear a similarity (as I shall show hereafter) to teeth that occur not unfrequently in our own Lower Carboniferous or Calciferous Sandstone series, and which are associated with undoubted *Tristychius* spines. Whilst this generic affinity may be asserted pretty confidently, there is much doubt as to whether the species from the two localities are the same; and therefore

* In Germar's 'Versteinerungen des Steinkohlengebirges von Wettin und Löbejun,' p. 71, tab. xxix. fig. 4b, and reproduced in Pl. VII. figs. 2 and 2a.

† *Loc. cit.* fig. 8; reproduced in Pl. VII. figs. 3 and 3a. May not his *Chilodus gracilis* be a *Diplodus* tooth? *loc. cit.* fig. 2, reproduced Plate VII. figs. 4 and 4a. One-pronged *Diplodus*-teeth are occasionally met with, whether due to fracture or not it is not easy to say.

‡ *Loc. cit.* fig. 5, a, b, and figs. 6 and 6a; reproduced, Pl. VII. figs. 5, 5a, & 6, 6a.

Tristychius fimbriatus, Stock, may be looked upon as distinct from, though probably related at no great distance to, *Styracodus acutus*, Giebel.

* *Tristychius arcuatus*, Ag.

This spine is rather common in the vicinity of Edinburgh. I have possessed or seen in other collections nearly a hundred examples. It appears to be commonest on the Burgh Lee horizon (Edge Coal), probably from the fact that the beds there have been pretty carefully examined; but it also extends down to some of the lowest beds of the Calcareous-Sandstone series of the district. I am acquainted with it from Abden, near Kinghorn, Fife (Edge Coal?), South Queensferry (Burdiehouse), Grange Quarry, Burntisland, Fife (Burdiehouse); Juniper Green (Wardie, collected by Mr. Henderson, and presented by him to the Museum of Science and Art); Hailes Quarry (Wardie); and from Carolina Park (Granton). A consideration of this ample material has elicited a few facts worthy of being put on record.

I have figured (Pl. VII. figs. 7 & 7a) the specimen collected by Mr. Henderson, and now in our collection, partly as being a good typical example of the larger form of the species, and also to show that the denticles near the point merge into a ridge with a ragged (scarcely denticulated) edge. The general shape has been preserved; but the proximal half has been much injured. On the side, at the point, there is a very small smooth area; and immediately below it the ridges and furrows are pretty strongly marked. Three distinct but not very prominent parallel ridges extend back from the anterior margin for a short distance; and the rest of the area is in this specimen finely and interruptedly striated. There is, however, a great range of variation in various specimens as to the strength of the sulcation and ridging. Some are nearly smooth, and those the largest; others, usually smaller specimens, are often strongly ridged and sulcated. These differences are so apparent in different examples that for a long time I thought a stable specific distinction might be made out between them; but wider experience has convinced me that a clear gradation can be easily traced between them.

Having now discussed the fragmentary evidence upon which the genus *Tristychius* has been hitherto chiefly known, we are able profitably to advance to the consideration of certain specimens in which that evidence is combined with other facts of a much higher order of importance. Amongst these the first to call for notice is a considerable fragment of the

vertebral column found in connexion with the remains of two spines (Pl. VII. fig. 8), the whole undoubtedly belonging to the same fish. This fragment has been preserved on a thin piece of weathered ironstone shale, and was picked up by myself at Carolina Park, near Edinburgh*.

Description.—There are the remains of two spines; the shape of the larger is well seen, chiefly as an impression, however, on the slab. It is $2\frac{1}{2}$ inches in length, a fairly large specimen. The cast shows that it was distantly and regularly striated. I can detect traces of one or two denticular impressions only. It conforms to typical examples of the species. This I interpret as the *right pectoral spine*. Slightly posterior in position and directed towards the opposite side of the axis are the much-broken remains of the base of a second spine (Pl. VII. fig. 8, *s*). This is proved conclusively by the pulp-cavity, which is seen in section at the edge of the slab. I interpret this as the remains of the *left pectoral*. They were probably paired spines at any rate; and their position with regard to the axial column is in favour of their being pectoral. There is much difficulty, however, in disentangling the confused appearances presented on that part of the slab immediately behind the spines; and at the anterior inferior angle of the slab some plant-remains† complicate matters, so that another reading could I dare say be defended. The position of the bases of the spines (almost overlapping) with regard to each other shows that there has been some disturbance during fossilization; and the disturbance which has pushed in the spine *s* (Pl. VII. fig. 8) has also pushed outwards the two neural spines *n* (Pl. VII. fig. 8), which occupy a peculiar and rather misleading position with regard to the spine *s'*. On the lower front angle of the slab there are some appearances dubiously referable to the pectoral fin (Pl. VII. fig. 8, *r*).

The remains of the axial column ($2\frac{1}{2}$ inches long) are in a tolerably good state of preservation. The apophysial elements are represented by a double series of closely approximated spines (neural and hæmal), consisting of granular cartilage, numbering between twenty and thirty in each row. They are rather better preserved on the neural than on the

* I have found this locality, situated at the extreme western end of the Wardie and Granton sandstones and shales, extremely prolific in fish fossils. Unfortunately they are not usually in good preservation. It is noticeable that nearly all of the specimens collected are referable to forms already and commonly known from the eastern and more frequently worked shales.

† Left out in the drawing.

hæmal aspect*. The spines of the neural row where best preserved are about 4 lines in height, triangular, and acutely pointed, the points being directed backwards. The hæmal spines (not well preserved) appear to alternate with the neural, are apparently of the same size and shape, and are directed forwards. Some allowance must be made, however, in this description, for *post mortem* disturbance and alteration.

The axis evidently consisted of a *persistent notochord*.

In this (so far as I am aware) the earliest known shark in which readable traces of the axial skeleton have been preserved, it is important to observe that these conform in rather a significant way to those types of vertebral organization which are regarded as the most ancient and the simplest. The discovery of this single specimen, however, is not sufficient to justify any certain conclusions as to the presence or absence of a more highly organized skeleton in other sharks of the same age. Prof. Newberry has indeed drawn attention † to an interesting specimen found in the Carboniferous rocks of Ohio (Waverly group), which he considers to represent a grade of organization in some respects higher than in most of the sharks of the present day. His remarks are of great interest, and need no excuse for being quoted. He says:—"I should also mention in this connexion a remarkable shark's tail found at Vanesburg, Kentucky. . . . This specimen, which is nearly a foot and a half long, shows the outline of the heterocercal tail of a shark which must have been 8 or 10 feet in length. The vertebral column is seen to reach far into the upper lobe of the tail. The vertebræ have certainly disappeared, leaving a smooth band to mark the space they occupied. This is bordered on either side by the impression of linear pointed apophysial bones, which were evidently much better ossified than the centra of the vertebræ. The lower lobe of the tail is formed by a number of *strong ossified rays*! This shows that this Carboniferous shark. . . . had a skeleton in some respects more fully ossified than most of the sharks of the present day." This brief notice, which he promised to supplement by a full description ‡, possibly may not represent his riper views as to the reading of the specimen; but it appears to me that, taking the description as it stands, there are several assumptions which are scarcely warranted by the facts; and chief of these is the implication that the axis was

* I consider the upper row as figured to be neural, though there is not much to show which is neural and which is hæmal.

† Geol. Surv. Ohio, vol. i. part 2 (Palæontology), p. 270.

‡ I am quite ignorant whether his promise has been fulfilled or not.

segmented, and, moreover, that the segmentation had proceeded so far as to be represented by distinct centra. So far as I am aware, there is no very convincing evidence at present available that any Carboniferous shark possessed centra. Numerous biconcave vertebræ have indeed been discovered, especially in the English coal-measures; but further observations are wanting before any of these can be referred with certainty to the skeleton of a Selachian fish.

The next specimen to be described is preserved in a nodule, and is valuable as affording information more particularly with regard to the exoskeleton of the fish. The nodule measured about $8\frac{1}{2} \times 7 \times 3$ inches before it was broken up for examination. I found it at Hailes Quarry, near Edinburgh, in the Calcareous-Sandstone series. The part protruding from the bank of shale had become a good deal weathered, and a considerable fragment must have at some time dropped off and become lost. The weathering has extended inwards for an inch or two, which is so far a fortunate circumstance, as a better view is got of the teeth than would have been possible otherwise. The rest of the nodule is hard and unweathered; and though I succeeded in developing the spines and several more teeth, something has no doubt escaped detection*.

Description.—The *teeth* are seen to be numerous; but it is impossible accurately to estimate their number, as they lie in much disorder, and many of them are very imperfectly seen. One of the largest (Pl. VII. fig. 9, nat. size) is $3\frac{1}{2}$ lines wide and $1\frac{1}{2}$ line high. The middle cusp is well developed, and is flanked by lateral cusps, three on each side (one of them is broken away in the example figured). These decrease in height, first suddenly as compared with the middle cusp, then more gradually with regard to each other. The cusps are strongly grooved. The grooves are flexed, and diminish in width as they converge towards the apex. The wide spaces that separate the cusps are also deeply grooved. This deep sulcation gives the tooth a strikingly ornamental and characteristic appearance. The inserted portion is short, and covered with equally spaced narrow ridges (Pl. VII. fig. 10). These ridges are apparently prolonged beyond the base into root-like attachments, and in some specimens they appear to bound cavities in the bases of the teeth. It is also worthy of note that the free portion of the tooth is very oblique to the base, a narrow groove marking the division between them. The other teeth differ from the one described chiefly in the varying depth of the sulcation and in the distances the cusps are set apart

* Shark nodules are particularly refractory under development.

from each other. In a few cases the base of one cusp rises from the base of its neighbour without any distinct space intervening. The middle cusp of one large tooth shows at its base small depressed elliptical areas enclosed by folds of the ridges.

It is rather singular that this elegant tooth should for so long have escaped detection; nevertheless, so far as I have been able to discover, it has not been previously described. It bears a general resemblance, however, to the teeth figured by Giebel * as *Hybodus carbonarius* and *Hybodus vicinalis*; and the evidence is in favour of their being allied.

A very pretty little tooth found by Mr. McLeish in the Calciferous-Sandstone series near Bathgate, and given to me by Mr. Henderson for examination, shows (Pl. VII. fig. 11) some deviation from the teeth in the Hailes specimen. In it the middle cusp is nearly of the same width from the base to the apex, and the ridging and sulcation are rather more regular; but these are differences which may be expected to occur in different individuals of the same species and in different positions in the mouth. I do not think it is specifically distinct.

I have figured (Pl. VII. fig. 12), from another specimen, a few teeth that lie almost undisturbed. The information derivable from the Hailes specimen is rather meagre as to those points connected with the buccal cavity upon which light might be expected to be thrown by the discovery of a tolerably good specimen. After a prolonged scrutiny of the material, I think the following statements may be considered as at any rate not widely removed from the truth. The greatest width of the aperture was from 2 to 3 inches, probably more. The mandibular and palatal cartilages were curved, the curves being broadly elliptical or circular. The teeth were set in numerous compact rows, one row behind another, in regular (not, I think, alternate) order, which (in a second specimen) are seen to occupy a space of about an inch, measured in the direction of the axis.

The Spines.—In this and the following specimens I have found the spines associated with the teeth in an identifiable condition. In this they number *four*; and though all are fragmentary, the shape and sculpture of the fragments are well preserved. There is not the slightest doubt that they perfectly resemble each other in size and contour, and that the ornamentation is identical in every respect. There is also no doubt that they are easily identifiable with *Tristychius arcuatus*,

* *Loc. cit.* Reproduced on Pl. VII. figs. 5, 5 a, & 6, 6 a.

Ag. This is a matter of evident importance; for upon the correctness of the reference depends a great part of the value of this communication. I have therefore given figures (Pl. VII. figs. 13 & 13 *a*) of the best-preserved fragment, and placed them beside the typical form (Pl. VII. fig. 7) for comparison.

The number of spines found with this specimen is quite conclusive to my mind as to the fact that some of them (perhaps all) belonged to the horizontal fins. If any were dorsal (prepinnae or not), they did not differ from the paired spines. Yet a real distinction has apparently been established by Messrs. Hancock and Atthey* between the paired and dorsal spines of *Gyracanthus*; and, from analogy, we should be prepared to expect that that distinction would hold good for other genera that possessed both.

There is no evidence of the presence of *sphenonchi*, the cephalic spines found associated with *Hybodus*.

Cuticular appendages.—There are a number of minute bodies scattered all over the stone, which are the remains of the dermal skeleton. They are so small, however, so much fractured, and simulate by their sculpture (where obscurely seen) the grooved cusps or bases of the teeth so closely, that it is exceedingly difficult to get a view of a specimen sufficiently isolated to be able to say with certainty what was its shape. In front of the largest fragmentary spine is a cluster of them, where they are rather better seen than elsewhere. They bear a pretty strong resemblance to clusters of caraway seeds. Sometimes two and sometimes three appear to be placed together, with distinct interspaces, however, and each traversed by one or two rather coarse striæ. The difficulties of observation, however, are so great that better material may correct this description. On holding the slab obliquely to the light and looking carefully with the lens, I think any one would, at any rate, be convinced of the existence of these tubercles, though opinions might differ as to their configuration. One that I thought I had isolated proved on more careful observation to be the base of a broken tooth, the striæ only distinctly appearing above the matrix! Sometimes I have thought that they approach the body figured by Giebel† as belonging to *Hybodus carbonarius*, and which there is good reason for believing was an appendage of the dermis. I have tried to figure a specimen, Pl. VII. figs. 15 & 15 *a*, which figures present my view of its shape; but I must leave to the future

* Northumb. & Durham Nat. Hist. Trans. vol. iii. p. 109.

† *Loc. cit.* (reproduced Pl. VII. figs. 14, 14 *a*). His figure is probably incorrect.

the corroboration or disproof of the accuracy of the representation. If my reading is correct, they bear a rather striking general resemblance to those found associated with the spines of *Ctenacanthus hybodontoides*, Ag., for the knowledge of which association we are indebted to the painstaking researches of Messrs. Hancock and Atthey. I owe a large fragment of this spine to the kindness of my friend Mr. J. M. Campbell, of the Kelvin Grove Museum, Glasgow, who obtained it from the Coal-measures of his district. On splitting the shale on its posterior side I found, as I was led to expect I should probably find from my experience with *Gyracanthus**, several well-preserved tubercles, of one of which I give a figure (Pl. VII. fig. 16). It has never, so far as I remember, been figured before; and a comparison of it with the tubercle of *Tristychius arcuatus*, Ag., will at once show that there is a decided resemblance between the two. A strong resemblance exists also between them and the tubercle of *Gyracanthus* (Pl. VII. figs. 17 & 17 a); and these are all, or nearly all, of the Carboniferous sharks upon which dermal appendages have as yet been clearly proved† to exist. Nevertheless this resemblance may not necessarily imply close affinity.

Cranial Cartilage.—The cranial cartilage preserved in this specimen presents the usual mosaic appearance with which the student of fossil sharks is familiar. When freshly fractured, the black glossy appearance, due to the change to bitumen, is apt to deceive the unwary by an appearance simulating that of minute ganoid scales, such as are found on *Acanthodes*.

The next and last specimen to be described occurs in a nodule, found by myself at Trinity near Edinburgh, in the Calcareous-Sandstone series (Wardie horizon).

The nodule is not entire; it contains, however, the remains of the cranium, and is valuable as throwing light upon the dentition of this fish. The nodule measured $5 \times 4 \times 2$ in. (before it was broken up for examination) and was very pyritous and hard.

Description.—I succeeded in developing a fragment of one spine. It conforms in sculpture so closely to those last described that all might have belonged to the same fish. What can be seen of its shape agrees also; and the denticulation on the posterior area is identical. There can be no doubt that it belongs to the same species.

* The shale at the back of the spines should always be carefully examined for tubercles.

† Many very different dermal buckles or tubercles, however, have received special names, having been mistaken for teeth.

Cuticular Appendages.—Dimly seen ; but there are traces of them, and these do not differ (so far as can be made out) from those described as belonging to the last specimen. They are most visible on the extreme posterior edges of the halves of the nodule.

Teeth.—On opening this nodule I thought I had settled the long-standing controversy as to the true nature of the bodies described by Agassiz as *Ctenoptychius pectinatus*, and believed by him to be teeth, but by Messrs. Hancock and Atthey* to be appendages of the dermis. A number of broad, low, sulcated teeth were seen lying in much disorder, yet compacted together, and forming evidently no inconsiderable portion of the armature of a Selachian mouth. An examination with the lens, however, resolved the majority of these teeth into forms with which I had been made very familiar by the material previously considered in this paper ; and I must confess to a moment of keen disappointment as this fact became apparent. Nevertheless, after repeated examination of the specimens under every optical condition, and after a consideration of other evidence, I have gradually been led to adopt the view that *Ctenoptychius pectinatus* is a part of the dentition of *Tristychius arcuatus*,—that is to say, that the teeth described in the last specimen and well seen in this (teeth with elevated median cusps and well-developed lateral cusps, strongly grooved, and with short striated and rooted bases) are accompanied in the same mouth, but in a different part of it, by teeth with no specially raised median or lateral elevations (the fasciculations of these teeth may probably, however, be homologous with the cusps of the other kind), with a low, nearly straight area, with well-developed bases, fringed (in many specimens) by root-like attachments. The gradations between the two kinds (if we may hope that a clue has been given) is not so very surprising. Slightly elevate the grooved and (already) fasciculated denticles of *Ctenoptychius pectinatus*, first at the middle and then at the sides, and you have *Tristychius arcuatus* teeth. Depress (and in some teeth the elevation is slight) the cusps of the latter, and you have the former. It is a great pity that the evidence furnished by the specimen is no clearer ; yet I consider it sufficient to warrant the expression of these views. In most of the teeth that are visible the distances between the cusps are much reduced when compared with some of those described in the preceding specimen. In one

* Northumb. & Durham Nat. Hist. Trans. vol. iii. p. 116. See also a note by myself in the Ann. & Mag. Nat. Hist., April 1882, p. 256. Messrs. Hancock and Atthey acknowledged their great resemblance to teeth.

tooth (Pl. VII. fig. 18) the middle cusp is much lower than in the others; and as it lies with its convex aspect uppermost, deeply grooved and prominently ridged, the lateral cusps on one side hardly at all differentiated from the rest of the free area, the resemblance to *Ctenoptychius pectinatus* is striking. In other places, particularly in one place (it requires close observation to detect it), the appearances are interpretable as those of a series of fan-shaped, ridged, and denticulated bodies, resembling the smaller forms of *Ctenoptychius pectinatus*. It is just here, however, in these crucial cases, where observation is most difficult. A little confirmatory evidence may be gleaned from the observations and figures of Giebel*, previously discussed. His *Styracodus acutus* † reminds one of *Ctenoptychius*, and is accompanied by a spine which appears to resemble that of *Tristychius*.

At Burch Lee, where the Carboniferous beds have been searched for fossils perhaps more thoroughly than in any other locality in this district, *Tristychius* is one of the commonest spines, as *Ctenoptychius pectinatus* is one of the commonest fossils; yet, strange to say, the teeth (of which a good view has been obtained in the specimens that I have described) have never, so far as I know, been detected in that locality. I have obtained *Tristychius* spines and *Ctenoptychius pectinatus* associated in the fish-bed at Abden, near Kinghorn, Fife, but not the *undoubted* teeth of *Tristychius*. On the Wardie horizon, again, I have obtained the teeth and spines of *Tristychius*, but not a single detached *undoubted Ctenoptychius*. In the English Coal-measures *Ctenoptychius pectinatus* is common; but neither spines of *Tristychius* nor *undoubted Tristychius* teeth have been, so far as I know, discovered‡. It will thus be seen that the evidence from association or the lack of it is exceedingly conflicting and of dubious value, whether for the affirmative side or the negative.

On the whole, whilst believing that the two forms of teeth will be found to belong to the same fish, I do not yet consider it placed beyond question, and some reserve must be exercised before deducing much from it.

Summary.—The preceding descriptions indicate a shark of small size. The buccal opening seems to have been of considerable relative dimensions. The teeth were exceedingly numerous, and formed closely compacted regular (?) rows reaching back for a distance of probably from a half inch to an inch from the anterior extremity of the mouth. They ap-

* *Loc. cit.*

† Reproduced Pl. VII. fig. 19.

‡ I should be glad to be corrected here if I am wrong, as I possibly am.

pear to have been of two kinds:—one prehensile, with well-developed median and lateral cusps; the other without specially prominent elevations, and occupying a different position in the mouth. The skin was clothed with a dense armour of tubercles, the veritable shagreen of these ancient sharks. The horizontal fins (or some of them) were protected anteriorly by gracefully curved, ridged, grooved, and denticulated spines*. (The presence of dorsal spines, protecting fins or otherwise, is not proved.) There were at least four on every fish. They varied a good deal in different individuals, but were *identically similar* in the same fish. The peculiarly curved spines known as *sphenonchi* and found with *Hybodus* do not appear on this fish. The endoskeleton was cartilaginous. The axis was persistently notochordal and unsegmented, but gave off (neurally and hæmally) spines that were composed of granular cartilage, closely apposed, probably alternately arranged on opposite sides of the axis, and directed backwards, the whole conforming to the simplest and most ancient types of axial structure. These statements, or the majority of them, rest upon tolerably well-ascertained facts, and though far from sufficient to elucidate the whole structure of the fish, form at any rate a useful contribution to its history.

Affinities.—Certain characters of which much is properly made in the classification of recent Selachian fishes, such as the presence or absence of the *membrana nictitans*, the confluence of the nostrils with the mouth, the presence or absence of spiracles, and the notching of the pectoral fins at their origin, are of course practically inapplicable to most sharks in a fossil condition, notwithstanding the surprising perfection in which such remains (in post-Palæozoic rocks) have been obtained. Nor do I think that the important series of investigations now being carried on with so much zeal by Prof. Hasse† will be of much service to students of the Selachian remains of the older rocks‡.

There abides, however, a valuable set of characters by the use of which a natural classification will no doubt be gradually conquered. Important amongst these are the pinnation and dentition. Science owes a debt of gratitude to Messrs. Han-

* I have seen one or two spines considerably larger than the largest figured.

† Das natürliche Syst. d. Elasmobranchier.

‡ He arrives at a singular conclusion with regard to *Tristychius*. He says (*op. cit.* 1st part, p. 62), "Alle diese Formen (*Asteracanthus*, *Myriacanthus*, *Priscacanthus*, *Tristychius*) sind demnach meiner Ansicht nach jüngeren Holocephalen zuzurechnen, welche sich mit *Asteracanthus* bis in den mittleren Jura hinein erstreckten und von denen *Tristychius* in

cock and Atthey for breaking down the traditionary notion that all fossil spines were dorsal.

In a clever research* (based upon very scattered material) they showed that spines of *Gyracanthus*, till then believed to be dorsal, were really pectoral; and I have been able to confirm their conclusions† by the finding of an interesting specimen containing well-preserved remains of the pectoral arch. I consider that Messrs. Hancock and Atthey, by these observations, have opened up a very promising future for selachological inquiry; for whilst the soft structures of the fins will (except in the rarest cases) have left no trace of their existence, we may expect that the spines which protected them will frequently be preserved in their proper relations.

I have thus tried to hint at the lines upon which any real advance in our knowledge of the Palæozoic sharks will probably be made. I am unfortunately not able to utilize them to any great extent in the discussion of the affinities of *Tristychius*. By the spines it is allied to *Ctenacanthus* through *Tristychius minor*, Portlock.

The appendages of the cutis differ greatly from those found on *Hybodus*‡. They bear, however, a strong resemblance to those of *Ctenacanthus hybodoïdes*, Ag. (= *Cladodus mirabilis*, Ag. §), and *Gyracanthus tuberculatus*, Ag. Their value for purposes of classification, however, is probably slight, judging from recent genera.

The teeth of *Tristychius* are even more Hybodont in facies than the probably closely allied teeth which Giebel referred to *Hybodus*||.

The *Ctenoptychius pectinatus* tooth (if proved to belong to this genus) would detract a good deal from the (probably extreme) value which has been attributed to the amount of the lateral cuspidal elevation of the teeth, in defining species and genera commonly ascribed to the Hybodontidæ. It is extremely unfortunate that the evidence is no clearer either for or against this unexpected association.

After weighing the evidence now set forth, I incline to the belief that *Tristychius* was Hybodont, but not *Hybodus*, and should not be much surprised if the future proved that *Cladodus* (or a part of it) was a closer ally than *Hybodus*.

* *Loc. cit.*

† In a paper read to the Edinburgh Naturalists' Field Club, but not yet published.

‡ I have had few opportunities of studying *Hybodus*. Excellent undescribed Mesozoic material exists; and it is much to be desired that some one who has access to it would describe it.

§ Messrs. Hancock and Atthey have brought forward an amount of evidence which amounts to proof that the tooth of *Ctenacanthus hybodoïdes*, Ag., was *Cladodus mirabilis*, Ag.

|| *Loc. cit.*

EXPLANATION OF PLATE VII.

- Fig. 1. *Tristychius fimbriatus*, Stock, nat. size.
 Fig. 1 a. The same, restored.
 Figs. 2 & 2 a. *Styracodus acutus*, Giebel (= *Tristychius* ?).
 Figs. 3 & 3 a. Referred by Giebel to *Hybodus* (= *Pleuracanthus* ?).
 Figs. 4 & 4 a. *Chilodus gracilis*, Giebel (= *Diplodus* ?).
 Figs. 5 & 5 a. *Hybodus vicinalis*, Giebel (= *Tristychius* ?).
 Figs. 6 & 6 a. *Hybodus carbonarius*, Giebel (= *Tristychius* ?).
 Figs. 7 & 7 a. *Tristychius arcuatus*, Ag., nat. size, and point enlarged.
 Fig. 8. *Tristychius arcuatus*, Ag., nat. size. *s*, fragment of pectoral spine; *n*, displaced neural spines; *r*, doubtful traces of the rays of the pectoral fin.
 Fig. 9. Tooth of *Tristychius arcuatus*, Ag., nat. size.
 Fig. 10. The same, showing base, nat. size.
 Fig. 11. The same, nat. size.
 Fig. 12. Four teeth of *Tristychius arcuatus*, Ag., in natural position, nat. size.
 Figs. 13 & 13 a. Spine of *Tristychius arcuatus*, Ag.: fig. 13 nat. size; fig. 13 a enlarged, to show the nature of the sculpture.
 Figs. 14 & 14 a. Dermal tubercle of *Hybodus carbonarius*, Giebel; fig. 14 enlarged.
 Fig. 15. Dermal tubercle of *Tristychius arcuatus*, Ag., much enlarged.
 Fig. 15 a. The same, one of the prongs much enlarged, to show the sculpture.
 Fig. 16. Dermal tubercle of *Ctenacanthus hybodoïdes*, Ag., slightly enlarged.
 Fig. 17. Dermal tubercle of *Gyracanthus tuberculatus*, Ag., much enlarged.
 Fig. 17 a. The same, one of the prongs much enlarged to show the diagonal sculpture.
 Fig. 18. Tooth of *Tristychius arcuatus*, Ag., enlarged, showing the slight elevation of the lateral cusps.
 Fig. 19. *Styracodus acutus*, Giebel.

BIBLIOGRAPHICAL NOTICES.

- Atlas de la description physique de la République Argentine contenant des vues pittoresques et des figures d'Histoire naturelle composées par le Dr. H. BURMEISTER, Directeur du Musée public de Buenos Aires, &c. Le texte traduit en français avec le concours de E. DAIREAUX. Deuxième section. Mammifères. Première Livraison. Die Bartenwale der argentinischen Küsten.*
Erläuterungen zur Fauna Argentina, enthaltend ausführliche Darstellungen neuer oder ungenügend bekannter Säugethiere von H. BURMEISTER, &c. Erste Lieferung. Die Bartenwale der argentinischen Küsten. Buenos Aires: Paul-Emile Coni. Paris: F. Savy. Halle: Ed. Anton. 1881.

DR. BURMEISTER'S 'Natural History of the Argentine Republic' was interrupted on the completion of the first section by a change of government. The author, however, had from time to time trans-

mitted his materials to lithographers in Berlin, and was preparing to continue the work at his own cost, when the governor of the province placed some funds at his disposal on condition that copies of the work should be distributed in the Republic, leaving the author free to issue his work in German and to dispose of it in Europe. Hence the progress of the book will depend largely upon the reception it may meet with among naturalists in Europe and North America; and we can only trust that every encouragement may be extended to the author in his endeavour to carry out the great undertaking on which he is engaged. The part before us, which is complete in itself, comprises a description of the whalebone whales which visit the Argentine coast. This memoir consists of seven folio plates, which illustrate the external appearance of the *Balænoptera intermedia*, and the osteology of this species, as well as that of the *Balænoptera bonaerensis* and the *Balænoptera patachonica*. These plates are beautifully drawn; some were prepared as far back as 1870. They form an important contribution to our knowledge of the species which they illustrate. There is a brief folio description of the plates in French, and a synoptical table of the length of the individual vertebræ and the number of vertebræ in the several regions of the body in the three species figured. The text is in German, and consists of thirty-six pages quarto, which, between the introduction and conclusion, describes in detail the three species figured, and gives some notice of the *Megaptera Burnmeisteri* and of the *Balæna australis*.

The introduction is a lively account of the author's first studies in 1825 of a fin-whale stranded on the island of Rügen; and this leads up to a recital of the difficulties which surrounded him in South America in having to make his studies on the sea-shore without the aid of trained assistants, and to measure these animals and their organs in the presence of excited and shouting crowds; but there is no need for apology on the author's part that he should confine himself on the present occasion chiefly to studies of the skeleton and of the external aspect of these whales; for although the species had been previously defined, it is only now that we are able to compare them in detail with the well-known fin-whales of Europe and of the Japanese seas.

The *Balænoptera bonaerensis* is given the first place in the description. A male stranded in 1867 has already been described by the author in the 'Proceedings of the Zoological Society' for that year, and, although in too advanced a stage of decomposition to permit near examination, was estimated to be 32 feet long, the head being 7 feet, the body and back 12 feet, and the tail 13 feet. Having given details of measurement and described the grey-white belly, the slaty-grey back, and the position of the genital organs relatively to the dorsal fin, he passes on to describe the baleen, which had already become detached from the head. The portion from one side which was recovered included only 192 plates out of a probable 250 to 260. The smallest plate was 7 or 8 centim. long; the longest, which was the 150th, was 32 centim. long; and behind this the plates again became shorter.

The skull is compared by the author with that figured by Eschricht as *Balaenoptera rostrata*, from which it differs in carrying on to the mature condition the form which distinguishes the northern whale in the young state. The Argentine whale has the snout relatively shorter and more pointed. The expansion between the premaxillary bones is posterior in position, and oval; the nasal bones are small and narrow; and the frontal bone reaches further forward and is narrower in the orbital region than in the northern form. The occipital bone has the parabolic contour of the young *Balaenoptera rostrata*, and covers the parietal and reaches the nasal, so as nearly to overlap the frontal bones. The fork of the maxillary is short. The palatine bone is short, and truncated rather than rounded in front. The jugal process of the squamosal bone does not extend so far outward as in the European species; and the jugal bone is slender and more curved in front. The vomer is relatively longer, and is partly cleft in front. These differences, which are regarded as specific, are accompanied by other differences in the vertebral column, though the number of vertebræ is the same. There are 7 cervical, 11 dorsal, 12 lumbar, and 18-20 caudal vertebræ. The first, second, fourth, and fifth cervicals are figured separately; and the author points out the many small differences which he regards as characterizing the South-Atlantic type, at the same time confessing that he no longer attaches so much importance to the lateral blending of the transverse processes into rings, as he did when the species was first instituted. In the dorsal region the spinous process increases in height from the first, in which it is 5 centim. long, to 38 centim. in the last dorsal. The height of the process increases to the middle of the lumbar region, and then declines, so that the process altogether disappears at the tenth caudal. The modifications of the vertebræ in the dorsal region are represented by drawings of the vertebral column and of the first and last dorsals, from which it is seen that the neural canal, which is at first triangular and has a slender arch, becomes ultimately vertically oval as the arch increases in strength, and the transverse processes, which were at first directed forward, come to be turned backward. The caudal region is characterized by the third to the tenth vertebræ having vertical perforations, which in the earlier vertebræ pass through the bases of the transverse processes, and in the later vertebræ through the centrum. There are twelve subvertebral bones in the caudal region. The tail-fin probably extended over six vertebræ. The ribs vary in the position of the tubercle and in their length and curvature. The first is 86 centim. long; the seventh is 146 centim. round the curve, while the tenth and eleventh are 92 centim. in the same measurement. The sternum is very remarkable in having the anterior limb of the cross subdivided into two; it is 44 centim. long and has the usual facets for the first rib on the middle of the posterior process. The scapula is chiefly remarkable for the sharp-pointed form of the acromion and coracoid processes. The fore limb is somewhat slender, with the humerus 28 centim. long and the ulna and radius 56 centim. long. Both these bones are curved

backward; and the olecranon projects conspicuously beyond both the ulna and humerus. There are five carpal bones, three forming a large proximal row below the epiphyses of the ulna and radius, and two small bones forming a lower row. These carpals are named the naviculare, lunatum, triquetrum, hamatum, and capitulum. There are four digits, which correspond to the second to fifth. The second is slender and contains five bones, the third stout, with six bones; the fourth has five bones, all stouter than those of the second; while the fifth digit has four bones, which rapidly diminish in size. The hinder extremity is represented by a single bone, probably pelvic, but of somewhat unusual form, though most like the pelvic bone of *Balaenoptera rostrata*. The hyoid is very similar to that of the North-Atlantic species.

The second species, *Balaenoptera patachonica*, is described from a perfect specimen, obtained in 1871, which was 50 feet long. Its form was more slender than the species just described, and closely resembles the *Balaenoptera musculus*, but was unfortunately stripped of flesh before seen by the author. He remarks on the differences which this skeleton shows from an imperfect specimen which was in the museum before it came under his direction, and is disposed to attribute the differences to sex and age. The skull is described in some detail, and the figures demonstrate its difference from other Argentine species; but Dr. Burmeister has been limited to the use of figures in comparing it with the northern form, which it most resembles. The first found specimen, which was figured in the 'Proceedings of the Zoological Society' for 1865, and which may therefore claim to be the type, differs, so far as can be judged from the figure there given, to an inconvenient degree from the new type now figured. The vomerine bones of the second specimen extend further forward than in the first type; but in that type the frontal bones extend further outward, so as to cover and hide the jugal bones, the nasal bones are narrower and longer, the notches external to the occipital condyles are deeper, and the snout tapers forward in a manner more marked. Other differences no less obvious are to be detected in the representations of the vertebræ and scapula; so that the species must be regarded as extremely variable; and this circumstance is suggestive of the probability that more abundant materials would do something towards blending it with the northern species, to which Burmeister indicates its affinity.

In his account of the neck the author restricts himself chiefly to establishing the differences between the vertebræ of the three species which he describes. The atlas of the *Balaenoptera patachonica* has the occipital facets too close together to receive the dentata between them as in the other species; and the form of the neural arch is distinctive of the axis in all three. The form and arrangement of the transverse processes differ considerably in the later cervicals. The length of the neural spine, as usual, is very little in the cervical region; but in the dorsal region it soon attains a considerable elevation, though relatively shorter than in the *Balaenoptera bonaerensis*. The height of the neural spine still increases a

little in the lumbar region before declining again so as to disappear in the tail. Just as the elevation of the spine is less remarkable than in the former species, so it dwindles away more gradually, being very small between the eighth and fourteenth caudal vertebrae. The differences from the *Balenoptera intermedia* are rather less striking, but are exhibited in the relative size of the centrum, the length of the transverse process and the form of the neutral spine in the caudal region, which is broad at its upper termination in the *Balenoptera patachonica*, and narrow or rounded above in the *Balenoptera intermedia*. But in the type described in 1865 this difference is much less marked.

The ribs increase in length from 92 centim. in the first to 175 centim. in the fifth; they then diminish to 120 centim. in the fifteenth, while the sixteenth is 85 centim. long. On one side there is a seventeenth rib 42 centim. long. The differences in form of the head of the rib are considerable when the specimen now described is compared with that figured in Proc. Zool. Soc. 1865. The sternum is of a broad T-shaped form, having the transverse limbs broad and strong, with a longitudinally oval perforation between them; the facets for the first pair of ribs are placed close behind the great transverse bar. The width of the bone is 45 centim., and its length 38 centim. In the remainder of the skeleton the divergences from the northern species are less marked. The differences between the scapulae of the two individuals are not very great in size. The fore limb has a length of 1.80 metre. The proportions of the several elements necessarily offer but few differences; the radius and ulna are conspicuous for their straightness, and the moderate elongation of the olecranon process, which scarcely extends beyond the stout humerus. The phalanges are comparatively uniform in character: the middle digit, as usual, is the longest; it contains seven phalanges, while there are six in the fourth, and five in the fifth digit. There is no trace of a hind limb, except a triangular bone, which is probably to be referred to the pelvis.

Having described the skeleton, the author discusses the characters on which he relies to distinguish it from *Balenoptera musculus*. In the head specific characters are found in the relative width of the parietal, frontal, and the orbital plate of the maxillary. Another difference is in the intermaxillary being stronger posteriorly; and it encloses a long elliptical hole above the vomer, while in the southern species this hole is short. The occipital bone is broader in the southern form. There is apparently one more dorsal vertebra and at least one more pair of ribs.

Balenoptera intermedia is known from both male and female specimens. It is intermediate between the *Balenoptera patachonica* and the *Balenoptera Sibbaldii*. The body of one specimen was 58 feet long; where thickest, behind the pectoral fin, it was about 9 feet high. The lower jaw extended somewhat in advance of the head. The pectoral fin has a sickle-shaped form, is 8 feet long and 3 feet wide in the broadest part, and is placed 5 feet behind the eye. The whole of the underside is marked in its anterior half with parallel

longitudinal grooves, about an inch deep, which extend forward to near the extremity of the lower jaw. The tail-fin is 4 feet long in the middle, and each lateral half is 8 feet long. The dorsal fin is only 15 feet from the extremity of the tail, and is placed above the anal region; it is $2\frac{1}{2}$ feet long. The body is dark slate-grey, with the back nearly black. The second specimen was 60 feet long, and had about one hundred furrows on the underside. The sexual differences are indicated; and it would seem that, notwithstanding the larger size of this individual, the anal aperture is only 15 feet from the extremity of the tail. The lobes of the tail are smaller, and each is only $6\frac{3}{4}$ feet wide; the back fin also is smaller. The male specimen is more slender and of a darker colour, and has relatively smaller pectoral fins. The baleen extends along the mouth for about 6 feet; the plates are triangular, and where longest have a length of 2 feet. They diminish in length to a few inches, and form mere pencil-like tufts.

In this second specimen the entire length of the skull is only 10 feet 8 inches, and is only a little longer, but relatively wider, than that of *Balænoptera patagonica*.

The outer border of the maxillary bone is remarkably convex; the lateral parts of the occipital bone do not diverge backward so much as in the other species; the nasal bones extend back to the line of the orbit; the premaxillary bones have a remarkable process inclining inward, where the frontal branch of the maxillary diverges—a condition somewhat similar to that seen in the *Balænoptera Sibbaldii*. Thus the distinction of this species from those which it most resembles is set forth. Similarly the vertebral column is somewhat stronger than in the foregoing species. There are seven cervical, fifteen dorsal, sixteen lumbar, twenty-six caudal vertebræ. The detailed descriptions and measurements assist the figures in illustrating the characters of this part of the skeleton; and the author follows the same general plan previously adopted in his descriptions. The sternum was lost in maceration. The fore limb is almost entirely unknown, though the author gives a beautiful drawing of its osteology on the basis, as he states, of analogy with its northern representative.

Megaptera Burmeisteri is still only known from the skeleton, 50 feet long, which was found overgrown with willows on an island in the delta of the Parana, where it lay partly buried; and but few additions have been made to the original materials, though among these are the tympanic and petrosal bones.

Balæna australis occurs off the South-American coast; but no specimen has hitherto been captured in the Argentine waters.

Finally, in a brief conclusion, the author justifies his mode of dealing with the material.

The descriptions are excellent throughout, and relieved by a recital of incidents in the history of the specimens which are not without humour.* The illustrations leave nothing to be desired; and the work will take a place among important monographs of the Cetacea.

Life of Sir W. E. Logan. By BERNARD J. HARRINGTON. 8vo.
Pp. 432. London: Sampson Low and Co., 1883.

IN this interesting volume the author has done good service by bringing together from many sources, and connecting into a continuous narrative, details of the life and work of one of the most devoted and single-hearted of British scientific men and public servants. We gather from the preface that the author's task was not self-imposed, and that he to a certain extent laboured under the disadvantage of not having known Sir William Logan in the earlier years of his work in Canada; but having undertaken the work, he has endeavoured to bring together such of Sir William's own words as will recall him to the minds and hearts of old friends, or enable those who were not privileged with his acquaintance to form an estimate of his character and work; and these objects he may be considered as having fairly accomplished.

William Edward, the third child and second of the five sons of William and Janet Logan, was born at Montreal on the 20th April 1798, and after receiving his early schooling from Mr. Alexander Skakel, a determined Scotchman thoroughly well acquainted with the art of flogging, but a good classical scholar and successful teacher, was in 1814 sent with his elder brother to the High School of Edinburgh, then in the zenith of its reputation. In 1817 he became a student of the University, receiving the first prize in mathematics, "with the goodwill of all the competitors," at the end of his single session at College, when his university career was brought to a sudden close by a resolution to enter into commercial life. He was received into the office of his uncle, Mr. Hart Logan, in London; and for the following thirteen years his life was that of a city man, with occasional holidays passed in France and Scotland. In 1831, his uncle having become interested in a process for smelting copper furnace-slugs, William Logan undertook the business management of the works at Morriston, near Swansea; and it was during his residence in Wales, extending over the period 1831-37, that the true bent of his genius towards stratigraphical geology first became apparent in the remarkable map of the South-Wales coal-field, laid down upon the then recently completed sheets of the one-inch Ordnance map of the district, which was exhibited at the meeting of the British Association at Liverpool in 1837. This, when subsequently incorporated by Sir Henry de la Beche into the maps of the Geological Survey, formed the standard for mapping the details of the other coal-fields in the kingdom. Another valuable service rendered as a volunteer by Logan to the Geological Survey was the introduction of the large sections on the uniform scale of six inches to the mile, which have been invariably used subsequently. In 1837 he was elected a Fellow of the Geological Society, and in 1840 contributed to its 'Transactions' an important paper "On the Underclays of the Coal-seams of South Wales," which he showed, from the invariable presence in them of the roots of *Stigmariæ*, to be the soils upon

which the plants forming the coal-seams originally grew. This generalization he subsequently verified in the coal-fields of Pennsylvania and Nova Scotia. In the latter locality he was the first (in 1841) to observe the traces of reptilian footprints in the Carboniferous system, a fact which has been somewhat overlooked by subsequent observers; but Logan's claim is vindicated by his friend and life-long associate Principal Dawson, in his work on the air-breathers of the coal-period, published in 1863.

After retiring from the management of the copper-works, subsequent to the death of his uncle in 1838, Logan returned to Canada in 1840 and was engaged in the researches last mentioned on the coal of the United States and maritime provinces. In the course of his explorations he was much impressed with the great mineral wealth of the basin of Pennsylvania, and had some thoughts of establishing himself as a coal-viewer in the United States; but upon the determination of the provincial government of Canada to institute a Geological Survey in 1842, he was, on the unanimous recommendation of the leading English geologists, De la Beche, Murchison, Sedgwick, and Buckland, appointed to undertake it, which he did in the spring of 1843, having for his sole assistant Mr. Alexander Murray, who was his constant associate during the whole time of his work in Canada, and subsequently directed the Survey of Newfoundland. Thenceforward for more than a quarter of a century Logan's life was entirely devoted to the working-out of the geological structure of his native country. He commenced in the eastern district of Gaspé, on the south shore of the Saint Lawrence, among Carboniferous and Devonian strata, and proceeded along the shores of Lakes Huron and Superior, through the valley of the Ottawa, and along the Labrador coast, all of which, now become familiar places to the student of American geology, were then unknown to geologists, and scarcely, if at all, topographically delineated, at any rate for more than a short distance from the shores of navigable waters, where hydrographic surveys had extended. This absence of topographical maps added enormously to the labours of the work; and for several years the method of traverse-surveys by counting paces and compass-bearings was added to the geological work proper, with the result of furnishing valuable additions to the cartography of the province; while the courses of streams navigable by canoes were plotted from similar surveys, in which the distances were determined by the Rochon micrometer-telescope. The value of the latter part of the work was specially noticed by Captain (afterwards Admiral) Bayfield, R.N., the Admiralty surveyor of the Saint Lawrence. The privations and discomforts experienced in the earlier years of Logan's work in Canada are abundantly evidenced by the numerous extracts from his journals describing incidents of camp life and references to a somewhat sparse dietary, in which spruce-partridges, porpoises, and porcupines figure largely, the last being spoken of as especially acceptable additions to the larder, while the short commons were aggravated by the persistent worries of mosquitoes and black flies during the greater part of the working

season. These privations and discomforts, it must be remembered, were encountered not by a young beginner having to make a way in life, but by a successful business man of mature years and large means, in the carrying-out of a self-imposed life-work, to which all Logan's energies were devoted without stint or reserve. Besides personal work, large sums of money were often advanced when the necessities of the government led to the reduction of the annual grants for a term of years. The work thus partially outlined met at last with a hearty recognition both in the colony and in Europe, especially when the magnificent collections made during the progress of the Survey were exhibited in the different international exhibitions in London and Paris from 1851 to 1868. Logan received the honour of knighthood in 1856, and was made Chevalier of the Legion of Honour in 1855, and Officer in 1867.

The more important portions of the scientific work of Sir W. Logan may, in the author's words, be summed up as follows:—

1. Investigations with regard to the origin of coal, which resulted in the establishment of the fact of the local origin of seams from growth in place.

2. The establishment of the Laurentian system as a great group of stratified crystalline rocks divisible into several groups, and containing at certain horizons evidences of organic life of the foraminiferal type (*Eozoon canadense*), the latter having been worked out jointly with Principal Dawson and Dr. Sterry Hunt.

3. The proof of the existence of a newer series of crystallized stratified rocks, the Huronian, resting unconformably on the Laurentian.

4. The identification of various formations younger than the Huronian, and the establishment of the fact that the lower palæozoic rocks rest unconformably upon the Laurentian and Huronian strata.

5. The production of numerous admirable geological maps, including not only the work of his own survey, but that of the geologists in the maritime provinces and the northern United States. The numerous official reports made at intervals during the progress of the survey formed the basis of the volume entitled 'Geology of Canada,' published in 1863, and which was the chief literary work of Sir W. Logan, in the preparation of which, however, he was largely assisted by Dr. Sterry Hunt. This is so well known that it will be unnecessary to go into detail as to its contents further than to state that it has been everywhere regarded as a model of what the geological handbook of a country should be, both as regards stratigraphical details and the accessory subjects of mineral and economic geology; and in these respects, though now nearly twenty years old, it remains unmatched by any similar subsequent publication.

The large geological map on the scale of 25 miles to the inch was among the latest as well as one of the finest of Logan's works, being remarkable for the beauty of execution and colouring. In the latter particular he took extreme pains; and the writer of the present

notice well remembers the long hours of work devoted to it in the Survey Office in Jermyn Street, the illustrious investigator, then full of years and honours, having thought it necessary to prepare the work in its minutest details for the publisher with his own hands—an example that might well be followed by some of our younger geologists, who, while bold in speculation, are not always so anxious to illustrate their opinions graphically as they might be.

In 1869 Sir William resigned the directorship of the Survey, but continued to occupy himself at intervals with geological investigations, in part caused by new and controversial views as to some of the earlier work on the eastern townships, which was incomplete when he left the colony for the last time in August 1874.

During the winter of that year, passed with his sister in South Wales, the disease to which he had been some time subject made rapid progress; and thenceforward, with a few brief intervals of improvement, he became progressively weaker, and finally passed to his rest on the 22nd of June 1875, in the 78th year of his age.

As an investigator into the intricacies of stratigraphical structure Logan was perhaps without an equal; and in the establishment of exact geological mapping as now practised in the British and other national Surveys his work was second only to that of his illustrious contemporary, Sir Henry de la Beche.

The author, though evidently without much personal knowledge of the subject of his memoirs, has done his work well, especially in the numerous selections made from journals and letters. Some of the latter, otherwise properly inserted at the end of the volume, contain details that might have been judiciously omitted. H. B.

A Monograph of North-American Phyllopod Crustacea. By A. S. PACKARD, Jun. 8vo. Washington: 1883. Extracted from the Twelfth Annual Report of the U.S. Geological and Geographical Survey. F. V. Hayden, U.S. Geologist in Charge.

THIS is a very comprehensive, well worked, and useful Monograph, based largely, but not wholly, on the consideration of North-American forms, and comprising:—I. The classification of the living Phyllopodous species; II. The geological succession of fossil forms; III. Geographical distribution of the existing species; IV. External and internal anatomy; V. Development and metamorphoses; VI. Relation to their environment; VII. Relations of the Phyllocarida (*Nebalia* &c.) to the Phyllopoda; and VIII. Bibliography. The following is the system and order of treatment in detail:—I. PHYLLOPODA, Latreille (p. 296), history and characters. Family *Limnadiadæ*, Baird (p. 297). Subfamily *Limnetinæ*, Packard, genus *LIMNETIS*, Lovén (p. 298); species (American) *Gouldii*, Baird, *macronotus*, Packard; *brevifrons*, Pack., *gracilicornis*, Pack. Subfamily *Estherianæ*, Pack. Genus *ESTHERIA*, Rüppell (p. 303): American species, *californica*, Pack., *Newcombii*, Baird, *compleximanus*, n. sp., *mexicana*, Claus, *Morsei*, Pack., *Belfragei*, Pack., *Jonesii*, Baird. Genus *LIMNADIA*, Brongniart (p. 311): American

species *americana*, Morse. Genus EULIMNADIA, Pack. (p. 311): American species *Agassizii*, Pack., *texana*, Pack., and *antillarum* (Baird). (Uncertain: *Limnadia coriacea*, Haldeman, *Limnadella*, nov. gen., and *L. Kitei*, n. sp.) Fam. Apodidae, Burmeister. Genus LEPIDURUS, Leach (p. 315): American species *glacialis*, Krøyer, *Couesii*, Pack., *bilobatus*, Pack. Genus APUS, Schaeffer (p. 319): American species *æqualis*, Pack., *Newberryi*, Pack., *Lucasanus*, Pack., *longicaudatus*, Leconte, *domingensis*, Baird, *Guildingii*, Thompson, *himalayanus*, Pack. (and *Dukianus*, Day, mentioned). Fam. Branchiopodidae, Baird. Subfam. Branchiopodinae, Packard. Genus ARTEMIA, Leach (p. 329): American species *gracilis*, Verrill, *Guildingii*, Thomps. Genus BRANCHINECTA, Verrill (p. 334): American species *paludosa* (Muller), *coloradensis*, Pack., *Lindahli*, n. sp. Genus BRANCHIPUS, Schaeffer (p. 340): American species *vernalis*, Verr., *serratus* (Forbes). Genus STREPTOCEPHALUS, Baird (p. 344): American species *texanus*, P., *Lealii*, Ryder, *floridanus*, P., *similis*, Baird. Genus CHIROCEPHALUS, Prévost (p. 351): American species *Holmani*, Ryder. Subfam. Thamnococephalinae, Pack. Genus THAMNOCEPHALUS, P. (p. 352): American species *platyurus*, P.

II. Geological Succession (p. 555). The North-American fossil *Estheria*, namely *E. pulex*, Clarke, *ovata*, Jones, and *Dawsoni*, Packard (not *Dawsoni*, Jones), and *Leaia Leidyi* (Lea), are here enumerated, with their descriptions; and a general Table of Rupert Jones's species (1862) is given, with *Branchipus* from the Isle of Wight added. This might have been augmented with other *Estheria* and *Leaia* from many sources of later date, as, for instance, the following (all Carboniferous):—

- Estheria Adamsii*, Jones, 1870.
- *Dawsoni*, Jones, 1870.
- *Freysteni*, Geinitz, 1879.
- *limbata*, Goldenberg, 1877.
- *Peachii*, Jones, 1870.
- *punctatella*, Jones, 1865.
- *rimosa*, Goldenb., 1877.
- *rugosa*, Gumbel, 1864.
- Leaia Jonesii*, R. Etheridge, Jun., 1879.
- *Kliveriana*, Goldenb., 1873.
- *Leidy*, var. *Baenschiana*, Geinitz & Beyrich, 1864.
- *tricarinata*, Meek & Worthen, 1869.

The general succession of the Crustacea is also illustrated by a tabular diagram (p. 361).

At page 361 Mr. Packard offers the following observations on the geological appearance and succession of the lower forms of Crustacea. "Simultaneously with the appearance of the larva-like *Agnostus* and the more highly organized *Paradoxides* &c., we find in the Lingula-flags the remains of a species of Phyllocarida, the *Hymenocaris vermicauda*. Mr. J. W. Salter, who was the first author to draw attention to the close relations of the fossil genera *Hymenocaris*,

Ceratiocaris, *Peltocaris*, *Dictyocaris*, &c. to *Nebalia*, has given us a series of sketches showing graphically the geological succession of this group and the Estheriadæ. *Hymenocaris*, which Salter regards as the more generalized type, lived during the primordial period; *Peltocaris* and *Discinocaris* (Woodward) characterize the Lower Silurian period; *Ceratiocaris* the Upper; *Dictyocaris* the Upper Silurian and lowest Devonian; *Dithyrocaris* and *Argas* the Carboniferous. No Mesozoic member of the family has yet been discovered; but as there are several species of *Nebalia* now living in our seas, it is reasonable to suppose that the type has existed in an unbroken succession from primordial times until now. The Palæozoic species were gigantic in size, some being a foot or more in length (the carapace of *Dithyrocaris pholadomya*, Salter, was seven inches long), while our recent *Nebalia* is less than an inch in length.

"The Potsdam Sandstone also contains the remains of a third grand division of the Entomostraca, the Ostracoda, remains of *Leperditia* having been found in Canada as well as in the Lower Silurian of Europe.

"No fossil Copepoda have yet been discovered; but we should scarcely wonder at this, owing to their soft bodies. Geinacker (in Bronn's 'Klassen und Ordnungen des Thierreichs') suggests that the Lernæans might have infested Palæozoic fish; and on general grounds we should think that they probably extended as far back as the primordial zone, inasmuch as highly developed Trilobites and Ostracodes appear there. Another argument is the interesting discovery, made in 1865 by Dr. H. Woodward, of the Cirripede *Turrilepas Wrightiana*, from the Wenlock Limestone and Dudley Shale of the Upper Silurian formation. Previous to this, according to Woodward, the oldest known Cirripede was the *Pollicipes rhæticus* from the Rhætic beds of Somerset, while the type is not uncommon in the Cretaceous, and has flourished from that period to the present.

"Of the Merostomata the oldest group is the Eurypterida, the Xiphosura not dating beyond the Lower Carboniferous. The Eurypterids have not been found below the Upper Silurian (Lower Helderberg in America); and the aberrant forms *Hemiaspis*, *Bunoödes*, *Pseudoniscus*, and *Exapinurus* are Upper-Silurian forms. Among the Xiphosura, *Cyclus*, the lowest form, is found in the Carboniferous, and ranges, according to Woodward, as far up as the Permian. In the same period occur *Bellinurus*, *Prestwichia*, and *Euproops*, being in this country [North America] found in the lower part of the true Coal-measures, and associated in the same beds with *Ceratiocaris*, *Eurypterus* (*Anthraconetes*), and certain Isopoda and Macrourous Decapoda (*Anthrapalæmon*). The genus *Limulus* first appears in the Jurassic; and the species differ but slightly from those now living.

"The more typical Phyllopoda made their appearance during the Triassic period. The lowest group, however, the Estheriadæ, appeared during the Devonian, a species referred to *Estheria* being found in that formation in Europe. The Cladocera are not known to have existed previous to the Tertiary period; and it was not until recently

(1862) that Von Heyden discovered the ephippium of a *Daphnia* in the Rhenish Brown Coal (Gerstäcker, in Bronn's Klass. u. Ordn.), said by Lyell to be of Eocene age. It should be noticed, however, that the fossil belongs to *Sida*, the most highly organized genus of the group; and as it is not unlikely that such pelagic forms as *Evadne* may have existed in the Mesozoic seas, if not earlier, I have ventured to run the point of the wedge into the Carboniferous period * [in the diagrammatic table of the vertical range of the Crustacea, p. 361].

"The Apodidæ date back to the early part of the Mesozoic, a Triassic species of *Apus* having been found in Europe, according to Mr. Salter."

With reference to the fossil Phyllopods, Mr. Packard adds, at p. 446:—

"While the posterior edges of the abdominal segments in *Hymenocaris* appear to be spined, as in *Nebalia*, there are some characteristics of importance in the fossil forms which deserve mention. These are the sculptured carapace, especially of *Dictyocaris*, in which the surface is reticulated. [A reticulate structure is observable in the parenchyma or soft part of the shell of *Nebalia*, although the exterior is smooth (note at p. 446).]

"Moreover the size of these genera was enormous; but if we, as we seem to be warranted in doing, regard *Nebalia* as a survivor and decrepit or old-age type of the order, which has lost the ornamentation of the integument, the size, and the telson even, being dwarfed, smooth-skinned, and in general very simple compared with the forms which existed at the time when the type culminated and before it began to die out, we may have an explanation of the greater simplicity of the carapace and abdomen of *Nebalia*, as compared with its Palæozoic ancestors."

III. The Geographical Distribution of the Phyllopoda (pp. 362–370), illustrated with a coloured map, deals with

- | | | |
|---|---|---|
| 1. The American Region . . | { | <ul style="list-style-type: none"> a. American Arctic Province. b. Atlantic or Eastern Province. c. Central Province. d. Californian or Pacific Province. e. Antillean Province. f. South America. |
| 2. The Europæo-Asiatic Region | { | <ul style="list-style-type: none"> a. European Province. <ul style="list-style-type: none"> 1. Western Europe. 2. Eastern Europe. b. Mediterranean Province. c. Siberian Province. d. Manchurian Province. |
| 3. The Indo-African Realm : | | a. African, and b. Indian Region. |
| 4. The Australian Realm. | | |

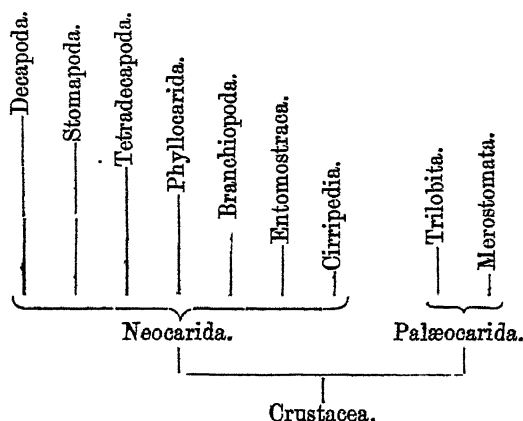
* Possible Daphnioid remains are referred to in the Geol. Mag. vol. vii. p. 219 (1870), as having been found in the Coal-measures of South Wales; and notice is there taken also of somewhat similar organisms, shown by woodcuts (figs. 10 and 11) in Emmons's 'American Geology,' part 6, pp. 39 and 40 (1869), and referred by him to Entomostraca.

IV. At pp. 370–415, the Morphology and Anatomy of the Phyllopoda are elaborately described, treating especially of the general and segmental structure; the appendages, eyes, and other organs; the internal anatomy (p. 397 &c.); and the homologies of the crustacean limbs and eyes.

V. The Development, Metamorphosis, and Genealogy of the Phyllopods (pp. 415–419) form another very interesting chapter.

VI. The Reproductive Habits and Development of the Branchiopodidæ are described at pp. 420–431.

VII. This part (pp. 432–452) treats of Mr. Packard's family PHYLLOCARIDA, mostly of Palæozoic age, and its systematic position. At p. 433 the anatomy and development of their recent type, the *Nebalia*, are first dealt with; and its relationship to the Decapods is thus indicated:—



The Nebaliads and the Palæozoic allies of *Nebalia* are thus enumerated (pp. 446–452):—

PHYLLOCARIDA, Packard, 1879.

Fam. NEBALIADÆ, Baird, 1850.

Genus *Nebalia*, Leach, 1814. With four known living species.

Fam. CERATIOCARIDÆ, Salter, 1860.

Genus *Hymenocaris*, Salter, 1852. One species.

Peltocaris, Salter, 1863. Two species.

Ceratiocaris, McCoy, 1850. Thirty-one species, with some varieties.

Echinocaris, Whitfield, 1880. Five species.

Discinocaris, Woodward, 1866. One species.

Spathiocaris, Clarke, 1882. One species.

- Genus *Isigocaris*, Clarke, 1882. One species.
Aptychopsis, Barrande, 1872. One species.
Dictyocaris, Salter, 1860. Two species.
Dithyrocaris, Scouler (*Argas*), 1835. Five species.
Rachura, Seudder, 1878. One species.

This list would be much augmented on revision up to present date. Several of M. Barrande's Bohemian forms, such as *Aristozoe* and its allies, evidently will have to be grouped with Mr. Whitfield's *Echinocaris*.

Part VIII. (pp. 453-458) is a long and useful bibliography, but not quite perfect as to fossil Phyllopods. An Appendix follows with—C. Th. von Siebold, On the parthenogenesis and artificial rearing of the Brine-shrimp (p. 463); C. F. Gissler, On parthenogenesis in *Artemia* (p. 466); and W. J. Schmankeiwitsch, On the transformation of *Artemia salina* to *A. Muehlhauseni* and to *Branchipus* (p. 466).

Thirty-seven carefully drawn lithographic plates and numerous good woodcuts, illustrating this valuable Monograph, show the details of the external and internal structure of the numerous genera and species described.

A Monograph of the Insectivora, Systematic and Anatomical. By G. E. DOBSON, M.A., F.R.S. Part i. 1882. Part ii. 1883. London. 4to.

DR. DOBSON is laying up for himself a store of heavy gratitude from all well-minded zoologists; but, however excellent their dispositions, there are some who will envy him. The author of the admirable 'Catalogue of the Chiroptera in the Collection of the British Museum' is now, with the assistance of the Government-Grant Committee of the Royal Society, writing a monograph on the very group of mammals that above all deserve it; for it is among the Insectivora that we find the most generalized forms of the group, and suggestions as to higher structural characters which are nowhere repeated.

He will not be envied for having undertaken a difficult task, but for the wisdom with which he devotes his leisure and his opportunities to the production of a monograph worthy of the name. From one circumstance or another most students of zoology find themselves the writers of scattered though in some cases very valuable essays. But these are, with rare exceptions, not the works that have a permanent value for science; it is only when they are focussed that their proper proportions are seen.

If we take a survey of the past we find this amply illustrated by the works of Cuvier, of Meckel, and of Owen in the great department of anatomical inquiry, in the impetus given to systematic zoology by the publications of the British Museum and of the Museum of Comparative Zoology at Cambridge, U. S. A., and in the promising field of geographical distribution by the great work of Wallace. These are examples of comprehensive works which, with others that will be easily recalled, have had as much influence for

good as have the patient investigations of various naturalists into the structure and life-history of a given type.

Those who write works like these are, whether they think of it or not, raising for themselves monuments of intelligent and well-directed industry which will last long after the contents of many Transactions and Journals have been digested, and have become themselves neglected.

So much is said against and so little is said for the opportunities which are given to zoologists in this country, that we cannot refrain from pointing out that Mr. Dobson returns his especial thanks to Sir W. Muir, who, at the time of the writing of his preface, was the enlightened head of the Army Medical Department.

The two parts of the Monograph now before us deal with six families:—the Erinaceidæ, Centetidæ, and Solenodontidæ; the Potamogalidæ, Chrysochloridæ, and Talpidæ. In addition to a detailed anatomical examination of a number of typical forms, all the species are dealt with in the fashion of a systematic zoologist; twenty-two plates, with a number of woodcuts, illustrate the text, and speak for the care that has been given to the supervision of their production.

One would require more than the usual calm superiority of a reviewer to closely criticise the work in these two parts; we propose rather to direct the attention of the reader to one or two points which seem to have been treated in a novel manner.

No one has ever studied the Mammalia without being attracted to their dentition; yet few seem to have studied it with profit; and even those who have made important discoveries are still in doubt as to some considerable questions of homology. We are glad to see that Dr. Dobson recognizes the value of formulæ in the manipulation of such questions; and, indeed, he does not recognize it merely, he demonstrates it. In four lines he shows us by an ingenious method his views as to the homologies of the teeth in *Gymnura* with the typical dentition of a diphyodont heterodont mammal, and those of the hedgehog:—

GYMNURA.

$$i. \frac{6=(2a+2b+2c)}{6=(2a'+2b'+2c')}, \quad c. \frac{2=(d+d')}{2=(d'+d')}, \quad pm. \frac{8=(2e+2f+2g+2h)}{8=(2e'+2f'+2g'+2h')}, \quad m. \frac{6=(2i+2j+2k)}{6=(2i'+2j'+2k')}.$$

ERINACEUS.

$$i. \frac{6=(2a+2b+2c)}{4=(2a'+2b')}, \quad c. \frac{2=(d+d')}{2=(d'+d')}, \quad pm. \frac{6=(2f+2g+2h)}{4=(2f'+2h')}, \quad m. \frac{6=(2i+2j+2k)}{6=(2i'+2j'+2k')}.$$

If we are to retain the term “canine” at all, we shall perhaps do well to follow Dr. Dobson and keep to the old definition that the “canine” in the lower jaw is the tooth that comes in front of the upper canine when the jaws are closed; on the other hand we have to remember that the connotation of canine is almost as much physiological as homological, and in the mole the “caniniform” tooth shuts behind, and not in front of, the upper canine. Mr. Dobson is, at any rate, bolder than Mr. C. S. Tomes, who some years ago refused to write out the dental formula of the mole.

The writers of zoological text-books must bear in mind *Microgale*

longicaudata; for now is there known to science a mammal with more caudal vertebræ than the familiar *Manis*.

The object of this notice has not been to review, so much as to give a note on, Mr. Dobson's work, and, if it may be, to increase the interest which is felt in its publication. To the author himself we have only to say that, as this work will before long be completed, we trust he is beginning to accumulate material for a monograph on some other order of that great group of animals in which, after all, men must always have the most lively interest.

MISCELLANEOUS.

Observations on Actinosphærium Eichhornii.

By Miss S. G. FOULKE.

It was stated that, while observing *Actinosphæria*, four individuals were seen to become fused, as it were, into one mass.

At the end of an hour this mass had separated into three *Actinosphæria*, two of the original four remaining fused into one.

This double one then became constricted, a little to one side of the middle, apparently being about to separate. In a few minutes the *Actinosphærium* began to eject, at the point of constriction, a thin protoplasmic substance containing transparent granulated globules and free granules. By a waving motion of the rays, the masses of ejected matter were broken up and the globules set free in the water.

These globules developed from one side an extremely long ray of finely granular protoplasm, slightly elongating at the same time, thus taking an oval shape. No trace of the axial threads peculiar to the rays of adult *Actinosphæria* could be discovered. The average length of these globules, including the ray, was $\cdot 1422$ millim., without the ray $\cdot 0127$ millim.

The next act of the globules was the sending out another ray from a point opposite to the first. Minute vacuoles appeared and ranged themselves close to the surface of the globule. Other rays were developed at various intervals of time. The appearance of the young *Actinosphæria* gradually became more perfect in resemblance to the parent. The growth was very slow, the perfect form not being attained for a period varying from one to two weeks, and the size was even then small.

The external layer of vacuoles of the *Actinosphærium* from which the globules had been ejected contained numbers of granules in active motion. In the different vacuoles the number varied from ten to about one hundred, as nearly as could be counted. They were usually congregated at one point, and seemed to be trying to force a way out.

Sometimes a globular mass of protoplasm was seen to run out upon a ray, and then, instead of returning to the body as usual, drop off into the water, and develop into a perfect *Actinosphærium*.

Several free cells, having rays, were observed, upon touching a ray of the *Actinosphaerium*, to glide down it in the manner usual to captured prey, and be reabsorbed into the body.

One globule of protoplasm, running out towards the point of a ray, stopped, and while motionless sent out a long ray at right angles to that supporting the globule. Another smaller globule ran out on this secondary ray, and, in its turn, sent out a third ray at right angles to the secondary ray, but parallel to the primary ray. It has been stated that the rays of the *Actinosphaerium* never branch; but the observer thought that the above phenomenon could be truly called branching, as all the protoplasm returned to the main ray, and thence to the body.

To ascertain whether any globules of protoplasm *artificially* freed from the body of the *Actinosphaerium* would develop in the same manner as those above described, an *Actinosphaerium* was crushed in the live-box so violently as to completely disintegrate it. The vacuoles were broken up, and the internal mass of protoplasm mixed with the water, only two or three small masses of the external vacuoles remaining intact. On removing the pressure all the fluid protoplasm was seen to gather itself up into globules, of sizes varying from .0507 millim. to .253 millim.

These globules contained vacuoles, the size and number of the vacuoles varying with the size of the globules. The water became free from protoplasm, though a large number of the granules, which had been contained in the external vacuoles previous to the crushing of the *Actinosphaerium*, remained swimming actively about in every direction.

The globules remained quiet for some minutes, and then began to extend pseudopodial rays. The vacuoles increased in number, and arranged themselves close to the exterior of the globules, those of the largest size pushing out the thin protoplasmic covering, so as to produce a strong resemblance to the perfect *Actinosphaerium*. The resemblance of each globule to the original *Actinosphaerium* became more and more perfect. The few masses of the original vacuoles also protruded rays, thus conclusively showing that the rays of *Actinosphaeria* are not necessarily dependent upon the central mass of protoplasm. The vacuole masses developed into perfect *Actinosphaeria* much more quickly than the globules formed of the central protoplasm, an hour or two being sufficient to perfect the development. The rays of all the immature *Actinosphaeria* were irregular and flattened, and in many cases lacked the axial thread.

The *Actinosphaeria* moved their pseudopodial rays freely in all directions, the rays being bent close to the peripheral layer of vacuoles.

From an original colony of eight individuals a small bottleful was manufactured in the manner above described, the time needed for development being in proportion to the size of the fragments into which the *Actinosphaeria* were divided. The above experiments were tried on many individuals, the only difference of result, in the various instances, being in the degree of completeness with which the protoplasm separated itself from the water. It was argued from

the above facts that the power of any part of an *Actinosphærium* to develop into a perfect individual was inherent, and not dependent upon any peculiar condition of the animalcule.

Fig. 8, pl. xli. of Leidy's Rhizopods of North America, which he doubtfully refers to the *Actinosphæria*, exactly resembles a medium stage in the development of the globules ejected from the body of the *Actinosphæria*.

The observer stated that the rays of *Actinosphærium*, when irritated by being compressed, would be retracted completely on all sides, and would again appear on the cessation of the disturbance.

The length of time needed for the development of the *Actinosphæria*, in the reproduction by natural means, was from seven to fourteen days; that needed for the development in the reproduction by artificial means was from one to two days.

In the latter case this length of time was needed only in cases when the crushing was carried to extremes, as when the *Actinosphærium* was simply divided into small pieces, a few hours were all that was needed to complete the development of the fragments.—*Proc. Acad. Nat. Sci. Philad.*, June 5, 1883, p. 125.

The "Crag Mollusca"—*Purpura tetragona*.

To the Editors of the 'Annals and Magazine of Natural History.'

GENTLEMEN,—In reference to the letter of Dr. Jeffreys, in your last number, wherein he says, "in *Murex* the canal is of moderate length, and is more or less covered over or closed above; in *Purpura* the canal is very short and quite open," I would mention that out of 113 specimens of the recent shell picked up on Felixstow beach, which I identify with *Purpura tetragona* and *Murex erinaceus*, 61 have the canal wholly open, and 52 have it more or less covered over or closed above. These, though varying very much in size, appear from the number of whorls to be all adult shells, *all sizes occurring in either group*. In the forms most approaching to the ordinary one of *M. erinaceus* (*i. e.* those most rugose and least elongate) the closing of the canal prevails; and the specimens with closed canal have usually the lip and varices most thickened. The specimens of *Purpura tetragona* which I have from the Felixstow Crag are all more or less mutilated, so that the length of the canal cannot be depended on; but in those I have from Walton Naze, and which are all in fine preservation, the canal is no shorter in proportion either to the length of the mouth or to the length of the shell than it is in *Murex erinaceus*. In its more elongated form, relative shortness of mouth, greater number of ribs or varices, and sharpness of shoulder, the variety *alveolatus* (fig. 7 b of tab. iv. of the 'Crag Mollusca'), which is almost the only one found in the oldest portion of the Red Crag (that of Walton), differs from the varieties found most abundantly in the rest of the Red Crag; and in these respects it departs more from the recent shell in question than do the latter. The varieties *vulgaris*, *intermedia*, and *tenera*

(figs. 7 *a*, *c*, *d* of same tabula) are the forms which most resemble the recent shell in question, and are those which chiefly occur in the Red Crag other than that of Walton, though specimens of *alveolatus* sometimes occur with them, which may have been lingering individuals of the disappearing Walton form, or merely derivatives from destroyed sand banks of Walton age, mixed up with the increasing and prevailing forms, in consequence of that destruction and reaccumulation of these banks which was proceeding throughout the formation of the oblique-bedded part of the Red Crag.

I should not have troubled you with the subject had I not thought it likely that some one might point out the identity in question as an oversight of my father's; and having assisted him in all his supplements, and knowing his views about *Murex erinaceus* in the Crag, I wished to anticipate such criticism by explanation. If there were any conflict between his view and mine, I should entirely defer to his; but there is not, as he was not acquainted with the variety in question.

In tab. iv. fig. 9, of the 'Crag Mollusca,' is represented a full-grown shell with *long open canal* under the name of *Murex tortuosus*. This shell Dr. Jeffreys, in the list to Prof. Prestwich's paper, by express reference to the page of my father's work describing it, assigns as "*Murex erinaceus*, var.," notwithstanding his statement in the 4th vol. of the 'British Conchology' (published four years previously) that the genus *Murex* has the canal closed ("covered over"), and his present assertion, that the closure of the canal distinguishes it from *Purpura*, and that the question of it "involves a difference not merely of a specific but of a generic and even family character." J. Sowerby's original figure of *M. tortuosus* (Min. Conch. tab. 434) shows the canal wholly open, as does my father's (and, I may add, as does every specimen of it that I have seen or can hear of); and my father's description of it (Crag Moll. vol. i. p. 40) is, "canal contracted but open."

I am, &c.,

SEARLES V. WOOD.

Aug. 17, 1883.

A Social Heliozoan.

Prof. Leidy exhibited drawings and made some remarks on a singular Heliozoan recently observed by him. His attention had been directed to it by Mr. Edward Potts, who discovered it, contained in considerable numbers in water, with vegetable débris, from Lake Hopatcong, N. J., where it had been obtained last autumn. The animal occurred mostly in groups composed of numerous individuals. One of these groups, of irregular cylindroid shape, 0.84 millim. long by 0.36 millim. broad, was estimated to contain upwards of a hundred individuals. They reminded one of a mass of tangled burs. They remained nearly stationary even for twenty-four hours, and exhibited so little activity, that without careful scrutiny they might readily be taken for some inanimate structure. The individuals composing the groups appear to be connected together only by mutual attachment of their innumerable rays; and none were ob-

served to be associated by cords of protoplasm extending between the bodies of the animals, as seen in *Rhaphidiophrys elegans*. The individuals associated together were of two kinds, those which were active, and a smaller proportion which were in an encysted quiescent condition.

The active individuals resembled the common sun-animalcule. The body was usually spherical or oval, but variable from contraction, colourless, granular, and vesicular, with a large central nucleus more or less obscurely visible and variably granular, with three or four or more peripheral contractile vesicles. The body had a thick envelope of delicate protoplasm, with innumerable and immeasurably fine straight spicules. The envelope with the spicules extended in numerous conical rays, from which proceeded numerous immeasurably fine granular rays. The encysted individuals presented the same essential constitution, except that the body was regularly spherical, enclosed by a structureless envelope or membrane, contained no contractile vesicles, and the enveloping protoplasm was devoid of granular rays. The body of the active individuals measured from 0.024 to 0.036 millim. in diameter; in the encysted individuals usually about 0.02 millim. An active individual, with the body 0.033 millim. in diameter, with its envelope was 0.055 millim. in diameter. An encysted individual, with the body 0.02, with its envelope was 0.036 millim.

The active individuals were observed to feed on two species of minute monads, which were swallowed in the same manner as in *Actinophrys*. After some hours a few individuals appear to have separated from the surface of one of the groups; but they were as stationary and sluggish as when in association with others.

The species is apparently distinct from others which have been previously noticed, and may be named *Rhaphidiophrys socialis*.—*Proc. Acad. Nat. Sci. Phil.*, April 1863, p. 95.

On the Genus Hyliota. By GRACEANNA LEWIS.

By a letter of inquiry from Prof. G. Hartlaub, M.D., of Bremen, Germany, concerning some rare African birds of the genus *Hyliota*, attention has been drawn to the specimens now in this Academy, of which there are three, all of them being male birds.

The question at issue is whether there are two distinct species or only one; and as distinguished authorities differ on this point, it seems proper to offer to ornithologists the testimony which these specimens afford.

The genus was first characterized by Swainson, who described the species *H. flavigaster*. The bird was at first supposed to belong to India, but was subsequently found to inhabit N.E. Africa and Senegambia, and was for a long time the only known species of the genus. Our specimen agrees moderately well with Swainson's description, but is, no doubt, an immature male; the wings are brownish and are not edged with glossy purple, but instead with a dull greyish white. The two external pairs of tail-feathers are edged more or less with white, as in the female. The band of white on

the wing is formed largely by the middle and greater coverts, and, beginning nearly at the outer edge of the wing, continues obliquely across the roots of the primaries, secondaries, and tertials, meeting on the back with the white of the rump, so as to form a deep curve over the folded wings and back. The white on the wing is even more extensive than is apparent. On lifting the overlying dark plumage, this colour is seen to involve nearly all the upper portion of the wing, the internal surface of which, as well as the axillaries, are white. The outer greater coverts are white at the base, but are black glossed with green on their margins; on the external feather the black is so reduced as to leave only a border on a white ground. The whole upper plumage of the head and back as far as the rump is of deep blue-black with glossy steel-blue reflections.

In 1851, J. and E. Verreaux described in the *Rev. et Mag. de Zool.*, p. 308, a second species, *Muscicapa(?) violacea*. In the same year, H. E. Strickland brought home from the river Gaboon a specimen which he described in Jardine's 'Contributions to Ornithology,' 1851, p. 132, under the name of *Hyliota violacea*, after having had the opportunity of consulting the manuscript of Verreaux, to which he refers. He remarks as follows:—"This bird is interesting as affording a second species of a genus of which one specimen only, the *H. flavigastra*, Swains., of Senegal, was hitherto known. It much resembles *H. flavigastra*, but differs in its broader beak and the less extent of white on the wing. Whole upper parts black with a steel-blue gloss, of a rather more purple hue than in *flavigastra*. Three or four of the greater wing-coverts next the body are white (in *flavigastra* the whole of the middle, and the basal half of the greater coverts are white). Lower parts pale cream-colour.

"Total length 5 inches; beak to front .5, to gape .7, broad $2\frac{1}{2}$; wing .3; medial rectrices .1 and .9, external .2; tarsus .7."

Of *Hyliota violacea*, as above described, the Academy possesses two specimens. One is the identical bird on which the species was founded by Verreaux; and its characters agree with the description of that author, as well as with that of Strickland, and also with that to be found in Hartlaub's 'Ornithologie Westaflicas,' Bremen, 1857, p. 98.

The second specimen in possession of the Academy belongs to the Du Chailu 1st Coll., and is also from the river Gaboon. This bird is mentioned in Cassin's 'Catalogue,' Proc. Acad. of Nat. Sciences, 1869, p. 51; but no description is given. Essentially its characters are the same as those of the type specimen of Verreaux.

In this species the only white to be seen on the whole wing is on one single feather belonging to the *inner* portion of the greater coverts. There are really about five feathers belonging to the series of ornamental coverts; but they overlies each other, and are so disposed that in the closed wing only one of them is visible.

The rump in both species is covered with long, loose, silky feathers, of a white or greyish-white colour from the base to near the tip, when the feather suddenly becomes dark and at the same time

pennaceous in structure. The only difference between the two species appears to be in the depth of the dark margin, or its entire absence in mature specimens of *H. flavigaster*. In Swainson's description of the type the rump is given as pure white; but it is not so in our specimen. The pennaceous dark border is nearly as deep as in *H. violacea*; so that this character cannot be relied upon as a distinction between the two species.

In his 'Ornithology of Angola,' p. 190, Prof. Barboza du Bocage acknowledges the receipt from M. Anchieta of one specimen of *H. violacea*. The description is that of a bird with a large amount of white on the wing. The description does not resemble the type specimen of Verreaux, but is much more nearly like *H. flavigaster*, Swains.

Depending on this description, R. Bowdler Sharpe gives it in his 'Catalogue of the Birds in the Collection of the British Museum,' instead of that of Verreaux, and, in consequence, considers *H. violacea* a doubtful species.

With the privilege of examination of the type, and of comparing this with the Du Chaillu specimen and the descriptions of Verreaux, Strickland, and Hartlaub, it seems impossible to suppose that the specimen sent by M. Anchieta to Prof. Bocage was that of a true *violacea*, but was either *H. flavigaster* or a form intermediate between the two.

The striking differences between the two species are:—the blue-black plumage in the upper parts in *flavigaster*, and the violet-black of *violacea*; the broad bands of white on the wing of the former, and the concentrated spot on that of the latter; the darker shade of the underparts in *flavigaster*; and the white thighs of the one and the black of the other, together with the larger size of *violacea*. They also inhabit different regions—*flavigaster* belonging to the N.E. of Africa and Senegambia, while *violacea* is found southward from the Gaboon to Benguela in West Africa.

Swainson points out the general resemblance of *Hyliota* to the African todies of the genus *Platystira*, and to the Old-world flycatchers of *Muscicapa*, with a bill so much lengthened and compressed on the sides that at first sight it might be mistaken for a *Sylvia*.

It also agrees with *Muscicapa* and *Cryptolopha* in having the base of the bill broad and depressed as far as the nostrils and then compressed to the extremity, the bill being so much lengthened in *Hyliota* that it becomes the tenuirostral form of the group to which it belongs.

The glossy blue-black plumage, white wings, and buff throat are in unison with related flycatchers. By the rump-feathers Swainson detects an analogy with the caterpillar-catchers of the Cebilepyrinæ.

In *Hyliota* the sexes differ remarkably in colour, as they do also in *Platystira*, such difference not being the rule in the family of the Muscipidæ. *Hyliota* agrees with the flycatchers in general by its small and weak feet and its syndactyle toes, the outer being connected with the middle as far as the first joint. The wings and tail are those of *Muscicapa*, in which group *Hyliota* is placed by ornithologists.—*Proc. Acad. Nat. Sci. Philad.*, June 12, 1883,

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XXV.—*Note on some Earthworms from India.* By FRANK E. BEDDARD, M.A. Oxon., F.R.S.E., Naturalist to the 'Challenger' Commission.

[Plate VIII.]

I AM indebted to the kindness of Professor McIntosh for the opportunity of studying a number of earthworms, collected chiefly in the neighbourhood of Calcutta, which had been sent to him from the Indian Museum at Calcutta for identification. He requested me to report upon them; and the following description relates to these specimens.

The collection contained four recognizable species—*Megascolex affinis*, *Perichæta armata*, *Perionyx McIntoshii*, and *Typhæus orientalis*, of which the last three are apparently new to science. There was also a bottle filled with a number of earthworms which were not sufficiently well preserved to enable me to determine the species; they were, however, evidently members of the genus *Megascolex* or *Perichæta*.

I received also a quantity of "castings," precisely similar to those figured and described by Mr. Darwin in his work on Earthworms, from beneath which all the specimens in the collection, with the exception of *Perionyx McIntoshii*, had been gathered.

Megascolex affinis, E. P.

Perichæta affinis, E. Perrier, Arch. du Muséum, t. viii. p. 106.

I venture to alter Perrier's name into *Megascolex affinis*, since Dr. Horst* has recently called attention to the identity of Templeton's genus *Megascolex*† with that subsequently termed *Perichæta* by Schmarda‡. The name *Perichæta* was apparently introduced by Schmarda owing to a misunderstanding of Templeton's definition of the genus *Megascolex*, for which he is indeed hardly to be blamed. The definition given by Templeton is very imperfect, and seems also to be inaccurate, since Baird§, who examined the type specimen of *Megascolex cæruleus*, was unable to find any difference between it and Schmarda's genus *Perichæta*. Judging from Templeton's description, *Megascolex* is very different indeed from *Perichæta*; he states, for example, that the generative organs are developed in segments 16, 17, and 18. Schmarda evidently considers that this description refers to the clitellum; but in any case the description is entirely unlike *Perichæta*, in which genus the testes are nearly always in segments 11 and 12; and the 18th segment, upon which the vasa deferentia open, never forms part of the clitellum.

However, since Baird has stated that *Megascolex* and *Perichæta* are identical, Horst is clearly right in wishing to retain the name *Megascolex*, which has a priority of fifteen years.

It might perhaps be advisable to limit the name *Megascolex* to those worms which are characterized by (1) the presence of a continuous ring of setæ upon the segments of the body, (2) the possession of a clitellum occupying segments 14–16 inclusive, (3) the position of the two male generative apertures behind the clitellum upon the 18th segment and of the single female aperture upon the 14th segment within the clitellum; while the name *Perichæta* might be applied to certain other forms which present a fundamental resemblance to the above-mentioned group, but differ in one or both of the following characters:—(1) in the ring of setæ upon each segment being discontinuous at one or more points; (2) in the clitellum occupying more or fewer segments of the body than three.

In this way several species recently described by Perrier|| from the Philippine Islands, such as, for example, *Perichæta*

* Horst, Notes from the Leyden Museum, vol. v. p. 183.

† Templeton, Proc. Zool. Soc. 1844.

‡ Schmarda, Neue wirbellose Thiere, 1861, Bd. I. ii. p. 18.

§ Baird, Proc. Zool. Soc. 1869, p. 40.

|| Perrier, Comptes Rendus, t. lxxxi. p. 1043.

luzonica (which has a clitellum of four segments and a ventral and two lateral areas deprived of setæ), together with some other forms described by Grube * and Horst † and a new species, (*Perichæta armata*) may be conveniently included in the genus *Perichæta*.

Hutton ‡ has recently applied the generic name *Megascolex* to certain New-Zealand earthworms described by him; these species also, with the exception of *Megascolex antarctica*, Baird, ought, on the view advocated here, to be referred to the genus *Perichæta* §.

It is very possible, however, that when more is known about this group of earthworms it will be necessary again to subdivide into several other genera the species which I propose for the present to call *Perichæta*. It is true that the name *Perichæta* applied, for instance, to such a form as *P. luzonica*, which is distinguished by *not* possessing a continuous circle of setæ, is (etymologically considered) a misnomer; but this is no objection whatever to its use. The practice of changing names because they are "inapt," so largely indulged in by many naturalists, ought not to be encouraged, as it throws zoological nomenclature, already sufficiently complicated, into the most utter confusion.

There were several specimens in the collection apparently belonging to this species; in structure they agreed exactly with the description given by Perrier ||, with the exception of the arrangement of the setæ upon the clitellum. On page 107 of his memoir is the following sentence:—"trois anneaux . . . forment la ceinture. . . sur lesquels on distingue parfois nettement le cercle de soies caractéristique des *Perichæta*." In all the specimens that I examined setæ were invariably present upon the clitellum, but confined to the ventral portion of each of the three segments of which it is composed, and *not* continuous all round the body, as the above quotation, if I understand it rightly, seems to imply. This small difference, however, hardly warrants the introduction of a new specific name; and since the specimens which M. Perrier described came from Cochín

* Grube, Phil. Trans. vol. clxviii., and MB. Akad. Berlin, 1877, pp. 509-554.

† Horst, *loc. cit.*

‡ Hutton, Journ. of New-Zealand Inst. vols. ix. and xi.

§ One of the species described by Hutton (*Megascolex sylvestris*) ought perhaps to be removed altogether from the genus *Perichæta* (or *Megascolex*), since it differs by the presence of the male apertures upon the 19th segment instead of the 18th as is universally the case in both *Perichæta* and *Megascolex*.

|| Perrier, Nouv. Arch. du Muséum, t. viii. (1872).

China, it may be regarded as merely a local variation. The stout mesenteries, the existence of which Perrier has mentioned in this species, are developed between segments 4-5, 5-6, 6-7, 7-8; they are connected with each other by tendinous cords, and thus form a very compact whole, which is no doubt of assistance to the animal in helping it to force its way through the earth.

Hab. Neighbourhood of Calcutta.

Perichæta armata, n. sp. (Pl. VIII. figs. 5-7.)

This new species I include within the genus *Perichæta* for the reasons just stated.

It is characterized by the setæ being absent from a narrow area upon the ventral median line and by the possession of a clitellum consisting of four segments, commencing with the 14th, but extending as far as the 17th segment; the male generative apertures are upon the first segment after the clitellum (18th segment of body).

The anterior portion of the body is slightly swollen, somewhat in the shape of an olive. There are about forty setæ to each segment, at any rate in those anterior to the clitellum; the posterior segments seem to have fewer setæ, twenty to thirty. Setæ are found upon the clitellum, and are distributed upon its segments just as they are over the rest of the body. One of the setæ is shown in fig. 5; the proximal end is rounded and somewhat swollen, the distal end sharply curved.

The alimentary canal entirely resembles that of other *Perichætae*. There are found in this species the glandular tufts which Perrier* was the first to describe in *P. Houletti* and other varieties as salivary glands; but subsequently† considered to be representative of the segmental organs of other earth-worms‡. In one specimen of *P. armata* which I dissected there were no less than nine pairs of these organs occupying segments 5-13.

There are eight pairs of contractile hearts occupying segments 6-13, of which the four posterior are the largest.

The three pairs of spermathecae are situated in segments 7, 8, and 9, but open on to the boundary-line between each of these segments and the one in front. The spermathecae are unusually large; each is provided (fig. 7) with two

* Perrier, *Nouv. Arch. du Muséum*, t. viii.

† Perrier, 'Comptes Rendus,' t. lxxviii. (1874) p. 814.

‡ Horst (*Niederland. Archiv f. Zool. Bd. viii.* 1879, and 'Notes from the Leyden Museum,' vol. v.) subsequently, but independently, arrived at a similar conclusion.

minute supplementary sacs, one on either side close to its external opening.

The prostate glands are large and very much lobulated; they are placed in segment 18; each is composed of two large lobes, which are again divided up into a number of lobules; the duct of the prostate gland unites with the vas deferens before its external opening on to the 18th segment.

In the furrow between each of the two large lobes of which the gland is formed is a thin-walled sac containing a number of specially modified setæ (fig. 6); the presence of this penial sac, found in the intracitellian genus *Eudrilus* and the post-clitellian genus *Acanthodrilus*, has never before been described in any *Perichaeta* or *Megascolex*.

The testes are brownish in colour and not unlike the segmental tufts, and for this reason are somewhat difficult to make out; there appear to be only one pair, situated in the 12th segment.

In the 9th segment, upon the mesentery bounding it behind, are a pair of glands which closely resemble the testes in external appearance. The specimens were not sufficiently well preserved to admit of a proper microscopical examination; so far as could be made out, the minute structure was not unlike that of the testes; and it is probable, from their position, that they are an anterior pair of testes, since the ovaries are in all other earthworms without exception placed behind the testes.

Hab. Neighbourhood of Calcutta.

Perionyx M'Intoshii, n. sp. (Pl. VIII. figs. 3, 8.)

The genus *Perionyx* was instituted by Perrier* for the reception of an earthworm which, although very closely allied to *Megascolex*, differs from it in at least three important characters:—(1) in the position of the clitellum and the number of segments of which it is composed; (2) the presence of segmental organs like those found in other *Oligochaeta*; and (3) in the arrangement of the male generative apertures. Only one species, *Perionyx excavatus*, is described by Perrier.

Perionyx M'Intoshii measures 15 inches in length and about one third of an inch in breadth, and consists of some 200 segments; its colour is violet, inclining to a reddish tint on segments 12–23; the clitellum was not developed.

The setæ are arranged in a continuous ring round each segment, as in *Megascolex*, upon a somewhat darker-coloured line.*

* Perrier, Nouv. Arch. etc. *loc cit.*

The male generative apertures are upon the 18th segment, and closely approximated to each other; they are situated upon a yellow-coloured area which extends a short way into the 17th and 19th segments respectively; the anterior and posterior margins of the 18th segment are slightly bulged at the place occupied by the generative area (fig. 3). The position of the generative apertures is somewhat intermediate between the condition found in *Perionyx excavatus* and in the genus *Perichæta*. Perrier describes and figures the apertures in the former species as being very closely approximated to each other, indeed actually contiguous, and occupying a depressed area distinct from the rest of the segment. In *Perionyx M'Intoshii* they appear to be more widely separated from each other, and also show a transition towards the arrangement found in *Perichæta* in that the area upon which they are situated is not depressed below the rest of the segment and so distinctly marked off from it as in *Perionyx excavatus*.

The single female orifice is situated on the 14th segment. The situation of the male and female orifices with respect to the setæ is different. The female orifice is situated *in front of*, while the male orifices are *behind* the circle of setæ, which in this part of the segment is somewhat bulged out in front, following its anterior margin.

The two pairs of spermathecæ are situated in the 8th and 9th segments and open between the 7th and 8th and the 8th and 9th, as in *Perionyx excavatus*; they also agree in form with the spermathecæ of *P. excavatus*, and consist each (fig. 8) of a simple sac without any development of supplementary pouches, which are always present, and in such great variety, in *Perichæta* and *Megascolex*.

The segmental organs exist in all the segments of the body, and seem to be of a larger size in the first ten or eleven segments. They are of the ordinary form, resembling those of the common earthworm; their apertures are evidently in the anterior part of each segment close to the median ventral line, but I did not succeed in seeing them. The presence of these segmental organs at once distinguishes the genus *Perionyx* from *Megascolex*; in the latter genus, as Perrier and Horst have shown, the segmental organs when present are invariably represented by tufts of glandular tubes, differing entirely from the typical segmental organs of the other Oligochæta*.

* A possible exception to this is *Perichæta leucocycla*, Schm. Schmarda (*loc. cit.*) gives some account of the segmental tubes (Schleimdrüsen) of this species; and it seems likely from his description that they are similar to the segmental tubes of *Perionyx* and other Oligochæta. Schmarda's figure of *P. leucocycla*, moreover, is not at all unlike my *Perionyx M'Intoshii*; and though his description is rather different, it is not impossible that the two species will eventually prove to be identical.

The body-cavity is also in communication with the exterior by a series of dorsal pores.

Some of the anterior mesenteries, those forming the anterior boundaries of segments 6-9, form a continuous covering for the pharynx, each mesentery being prolonged backwards from its point of origin on the body-wall in a cup-like fashion, and fitting into the inside of the succeeding mesentery; each of these mesenteries is also closely fastened to the one in front by a series of tendinous cords which arise from its anterior margin, and are attached to about the middle of the mesentery in front. This arrangement is very like that described by Perrier in *Anteus*, but nothing of the kind is mentioned by him as existing in *Perionyx*.

The alimentary canal is of the ordinary form. A rectum is developed at the terminal part of the intestine, from which it is marked off by a strong fold; its length is about $\frac{2}{3}$ inch. Like Perrier, I was unable to find any lateral cæca to the intestine.

The vascular system consists of the usual dorsal and ventral trunks connected by eight transverse arches occupying segments 6-13; of these the four posterior were considerably stouter than the others, and no doubt serve the purpose of contractile hearts. In the segments following, the dorsal vessel gives off two small trunks on either side.

The testes are two pairs of lobulate glands occupying the 11th and 12th segments; each testis is united with its fellow. As in *Perionyx excavatus*, the anterior pair is rather smaller than the posterior.

The prostate glands are large and well developed; each is composed of a number of small lobules, and differs therefore from the prostate of *Perionyx excavatus*, in which species the prostates are of circular form and exhibit hardly any traces of division into lobules. In this respect therefore *Perionyx M'Intoshii* approaches rather more nearly to the typical *Megascolex*.

Hab. Akhyab, Burmah.

Typhæus orientalis, nov. gen. et sp.
(Pl. VIII. figs. 1, 2, 4, 9-12.)

The anatomical characters of this earthworm appear to be quite different from those of any other genus as yet described; it belongs to the "Intraclitellian" group of Perrier.

External characters.—The largest of the three specimens which the collection contained measured 10 inches in length and about $\frac{1}{3}$ inch in breadth; the form of the body is cylindrical, and the anterior portion is not at all dilated. The setæ are arranged in four pairs, and are ventral in position; upon the segments which form the clitellum only

two pairs were visible, the outermost pair of each side being absent. The clitellum occupies four segments (14-17), but does not commence abruptly with the 14th segment. On the hinder part of segment 13 there is already a slight development of glandular matter.

Upon the 17th segment are the two male external generative apertures, which are situated upon a flattened area marked off from the rest of the body by a continuous raised margin; upon this area, and for a short distance in front of it, there is no development of glands; in front of the generative apertures, and corresponding to the lines of division between the segments, are three pairs of papillæ, and in the segment immediately following the generative apertures there is another pair; behind these again is a single papilla corresponding to the right-hand one of the other segments; and, finally, on the line of division between segments 12 and 13 there is a single papilla on the left side, which differs from the others in being of a rather smaller size and in having a central perforation. These papillæ were only present in a specimen which had a fully-developed clitellum. The papillæ (fig. 4) are oval in form, with the long diameter transverse to the axis of the body; in the centre of each, with the exception of the most anterior one, is an irregularly shaped depressed area. The position of the papillæ, situated as they are on the boundary-line of the segments, is unusual; in *Megascolex affinis* the two pairs of papillæ are situated in the middle of segments 17 and 19 respectively, and this position appears to be the same in other species of *Megascolex* which are provided with papillæ; but in *Pontodrilus* * the two large papillæ are situated on the boundary-line of segments 19-20, 20-21.

The enclosure of the generative orifices within an area distinct from the rest of the clitellum is not peculiar to the genus *Typhæus*; a similar condition has been described by Perrier† in two other Intraclitellian genera, *Anteus* and *Titanus*, and more recently by myself in a new genus, *Pleurochæta*‡. I may here remark that the pair of orifices on either side of the apertures of the prostate glands in this latter genus in all probability correspond to the genital papillæ just described, which in other species are frequently perforated and continuous with the ducts of small glands§.

In the anterior region of the body, between the 7th and

* Perrier, Arch. de Zool. Exp. t. ix. 1881, pl. xiii. fig. 1, vv.

† Perrier, *loc. cit.* pp. 51, 58.

‡ F. E. Beddard, Trans. Roy. Soc. Edinb. vol. xxx. pt. 2, p. 481.

§ Perrier, *loc. cit.* p. 107.

8th segments, are the slit-like orifices of the spermathecae. Dorsal pores exist in the segments behind the clitellum; they are, as in other earthworms, situated near the anterior margin of each segment.

Alimentary canal.—The mouth, which is precisely terminal in position and not ventral, leads into a small buccal cavity separated from the pharynx by a slight constriction. The latter is somewhat square in outline and broader behind than in front; it extends back as far as the 4th or 5th segment, and is attached to the body-wall by a number of muscles and tendinous bands, which collectively represent the mesenteries of this portion of the body. The upper surface of the pharynx is covered by a rich vascular network.

The oesophagus is long, and occupies segments 5–8; it is supported (fig. 2) by two large and thick mesenteries which form the boundary-line between the 5th and 6th and the 6th and 7th segments. Behind the oesophagus is the gizzard, divided into two portions—an anterior small thin-walled compartment, and a large thick-walled portion, the gizzard proper; this last has a nacreous appearance on the outside, and is lined by a very thick chitinous layer. The gizzard occupies two segments which, as usual, are not separated from each other by a distinct mesentery, though two tendinous bands, by which the lower surface of the gizzard is attached to the body-wall, are probably the representatives of a mesentery; at the hinder extremity of the gizzard, from the upper surface, a pair of stronger tendinous bands are given off, which traverse the mesentery lying immediately behind it, and are fixed to the ventral wall of the body. The oesophagus (fig. 2) is in like manner fixed in its place by similar tendinous bands.

Behind the gizzard follows the rest of the oesophagus, which at about the 17th segment passes into the intestine; the latter is distinguished by its greater calibre and somewhat thinner walls.

On the dorsal surface of the intestine, rather before the end of the middle third of the body, is developed a glandular mass (fig. 2). This consists of five separate glandular bodies occupying as many segments and increasing slightly in size from before backwards. In one specimen (apparently a young one) the posterior two glands were bilobed; in the other specimen that I examined, which had a fully developed clitellum, and was therefore adult, all were bilobed. The whole glandular mass is yellowish white in colour, and from one fourth to one third of an inch in length. It is situated above the dorsal vessel, which here appears to be considerably

dilated, and indeed in the region behind the glands dwindles so much in size as to be almost invisible.

These glands I regard as homologous with the "kidney-shaped" glands recently described by me in *Pleurochæta**. These are the only two genera, so far as I am aware, in which any thing of the kind exists. They probably represent a specialized condition of the intestinal cæca of the Leech and certain Polychæta such as *Aphrodite*. In the latter genus†, moreover, the cæca are branched, and thus present a nearer approximation to the complex glands of *Pleurochæta* and *Typhæus*. The two cæca of *Megascolex*, first noticed by Vaillant‡ in *Megascolex cingulata*, and subsequently described in several other species of the same genus by Perrier§, belong, no doubt, to the same category, and represent in a very rudimentary way these same glands.

The genus *Megascolex* itself, however, contains individuals which in this respect are more specialized; two species, *Megascolex Sieboldii* and *M. musicus*, possess no fewer than six pairs of these cæca||.

The *circulatory system* consists of a dorsal and a ventral vessel united by six transverse trunks or "hearts" in segments 9-14; of these the two posterior are slightly larger than the others.

The *nervous system* closely resembles that of other earthworms; the cerebral ganglia, hardly separated from each other, are placed on the line of division between the buccal cavity and the pharynx in the 2nd segment of the body. The ventral chain commences in the 3rd segment; the two or three anterior ganglia are considerably larger than the following ones and closer together; the ganglion occupying the 17th segment, and lying between the male generative apertures, is also, as usual, of larger size than the rest. From each ganglion two pairs of nerves appeared to take their origin—one at the anterior, and the other at the posterior extremity.

Segmental organs.—Instead of the ordinary simple tubes opening into the body-cavity by a ciliated funnel which are found in the common earthworm and the majority of the Oligochæta, there are in *Typhæus* a series of tufted glandular masses somewhat similar in appearance to the tufted glands which are almost universally found in the genus *Megascolex*, and re-

* F. E. Beddard, Trans. Roy. Soc. Edinb. vol. xxx. pt. 2, p. 493, pl. xxv. figs. 1, 11, 12, pl. xxvi. fig. 19.

† Gegenbaur, Man. d'Anat. compar. (trad. franç. par C. Vogt), p. 206, figs. 43, 44.

‡ Vaillant, Ann. des Sc. Nat. 5 sér. t. x. p. 233, pl. x. fig. 4 g.

§ Perrier, Nouv. Arch. du Muséum, p. 101, &c.

|| Horst, Notes from the Leyden Museum, vol. v. pp. 192, 194.

garded by Perrier and Horst as the homologues of the segmental organs. In *Typhæus*, however, they are somewhat different in appearance and far less conspicuous; instead of being developed in close relation to the mesenteries, they are situated near the anterior margin of each segment on the ventral wall of the body. Their microscopic structure was hardly distinguishable, owing to the bad state of preservation of the specimens; but it evidently differed from the structure of the tufted glands in *Megascolex affinis* and *Perichæta armata*. Judging from the position of the organs, it seemed very likely that the external aperture was situated anteriorly to the inner pair of setæ. These glands appeared to be present only in the anterior segments of the body; behind the clitellum I was unable to detect any.

In the most anterior part of the body, and occupying segments 3 and 4, is a large gland on either side composed of a number of these glandular tufts aggregated together (fig. 2). Eisig has recently shown in the Capitellidæ that there may be more than a single segmental tube to each segment; and, assuming that the glandular tufts of *Typhæus* are really the homologues of the segmental organs of other worms, which seems very probable, this genus presents another example of the same phenomenon. It is possible that this structure corresponds to the "glande à mucosité" described by Perrier as coexisting in *Urochæta* with segmental tubes of the normal type.

Generative system.—I was unable to find the ovaries or any trace of an oviduct or its external opening, which is so conspicuous in *Megascolex*.

The male organs consist of a large pair of testes, which extend through the 13th, 14th, and 15th segments. The vasa deferentia are two extremely fine tubes which open upon the 17th segment; each unites with the duct of the prostate gland of its own side shortly before its external opening. The "prostates" are two large coiled glandular tubes situated, one on either side of the body, in the 18th segment. In the specimen with a fully-developed clitellum the prostate was divisible into two parts—(1) the gland itself, a thick coiled bright-orange-coloured tube; (2) the duct, which differed in being of a smaller diameter and white colour. A thin muscular sac containing a number of specially modified penial setæ (fig. 11) is present, and is rendered extremely conspicuous by its nacreous glitter.

A single pair of spermathecæ occupy the 8th, and open between the 7th and 8th segments; each is provided with a short muscular efferent duct, at the junction of which with

the body of the spermatheca is a small appendage on either side; this appendage is formed of three short sacs uniting before their opening into the duct of the spermatheca; in colour they are very different from the spermatheca itself, being of a chalk-white, owing apparently to the thinness of the walls and to the presence of spermatozoa within; the main part of the spermatheca is reniform in shape, the efferent duct arising from the "hilus," and of a yellowish colour. The whole of this portion of the organ is covered by abundant blood-capillaries. Fig. 9 shows one of the spermathecae, viewed laterally, with its trifid appendage and the "segmental tufts" of the segments on either side of it. The only other Intracelitellian genera in which prostate glands (so commonly found in the Postclitellian forms) exist are apparently *Eudrilus* and *Pleurochaeta*; in the former genus Perrier* has described and figured two long sacs, which appear to represent prostates, and in *Pleurochaeta*† they are well developed. In having the form of a simple coiled tube the prostate glands of *Typhæus* are of a more primitive character than those of *Perichaeta*, which are complex lobulated glands; in *Pontodrilus*‡, however, the prostate has the same rudimentary structure.

Hab. Neighbourhood of Calcutta.

EXPLANATION OF PLATE VIII.

- Fig. 1.* *Typhæus orientalis*, from beneath. *cl*, clitellum; *a*, male generative apertures; *b*, genital papillæ; *sp*, apertures of spermathecae. Natural size.
- Fig. 2.* *Typhæus orientalis*, dissected. *a*, aggregate of segmental tufts; *b*, specially thickened mesenteries; *c*, pharynx, between which and the buccal cavity lie the cerebral ganglia; *d*, cesophagus; *e*, gizzard; *f*, intestine; *g*, testis; *h*, prostate gland; *i*, penial sac; *sp*, spermathecae; *v*, dorsal vessel, giving off six lateral hearts. Twice the natural size.
- Fig. 3.* *Perionyx M'Intoshii*. *m*, male aperture; *f*, female aperture; *sp*, orifice of spermatheca. Natural size.
- Fig. 4.* Genital papilla of *Typhæus*. $\times 4$.
- Fig. 5.* Seta of *Perichaeta armata*. $\times 300$.
- Fig. 6.* Penial seta of the same, terminal portion. $\times 300$.
- Fig. 7.* Spermatheca of the same. $\times 2$.
- Fig. 8.* Spermatheca of *Perionyx M'Intoshii*. Natural size.
- Fig. 9.* Spermatheca and neighbouring segmental tufts of *Typhæus*. $\times 4$.
- Fig. 10.* Seta of the same. $\times 300$.
- Figs. 11 a and b.* Penial setæ of the same, terminal portion. $\times 300$.
- Fig. 12.* Intestinal glands of the same. $\times 4$.

* Perrier, Nouv. Arch. du Muséum, t. viii. p. 74, pl. ii. fig. 26 *vs.*

† Beddard, *loc. cit.* p. 501.

‡ Perrier, Arch. de Zool. Exp. t. ix. 1881, pl. xiv. fig. 17.

XXVI.—Remarks on the Lizards of the Genus *Lophognathus*.

By G. A. BOULENGER.

I AM acquainted with four forms of *Lophognathus* which I think well entitled to specific distinction. Two species only have hitherto been described, viz. *L. Gilberti*, Gray, and *L. lateralis*, Macleay (Proc. Linn. Soc. N. S. Wales, ii. 1878, p. 103). Under the former name Gray (Cat. Liz. 1845) confounded two forms; but his description is chiefly penned from the one which has been excellently figured in the Zoology of the 'Erebus' and 'Terror,' and for which I will retain the name. It is difficult to say, from Macleay's description, what *L. lateralis* is. The principal characters of the four forms in the British Museum are as follows:—

1. *Lophognathus Gilberti*.

Lophognathus Gilberti, Gray, Zool. Misc. p. 53, and Cat. Liz. p. 250 (part.), and Zool. 'Erebus' and 'Terror,' pl. xix. fig. 2.
Redtenbacheria fasciata, Steindachn. Novara, Rept. p. 31.

Snout not longer than the distance between the orbit and the posterior border of the ear. Nostril a little nearer the orbit than the tip of the snout. Keels of the upper dorsal scales horizontal, forming parallel lines with the vertebral crest. Parotoid region with a few erect pointed scales. Gular scales very feebly keeled. A broad light band along upper and lower lip; a light band along each side of the back.

One specimen from Port Essington and three from the Swan river.

2. *Lophognathus longirostris*, sp. n.

Snout longer than the distance between the orbit and the posterior border of the ear. Nostril a little nearer the orbit than the tip of the snout. Dorsal scales all obliquely directed upwards. Gular scales very feebly keeled. A light band bordering the lower lip; a light band along each side of the back.

Three specimens from Champion Bay, N.W. Australia.

3. *Lophognathus labialis*, sp. n.

Lophognathus Gilberti (part.), Gray, Cat. Liz. p. 250.

Snout not longer than the distance between the orbit and the posterior border of the ear. Nostril a little nearer the tip of the snout than the orbit. Dorsal scales all obliquely

directed upwards. Gular scales very feebly keeled. A light band bordering the upper lip; a light band along each side of the back.

Two specimens from Port Essington.

4. *Lophognathus maculilabris*, sp. n.

Snout not longer than the distance between the orbit and the posterior border of the ear. Nostril equally distant from the orbit and the tip of the snout. Dorsal scales all obliquely directed upwards. Gular scales strongly keeled. An irregular light band from below the eye to the shoulder; lips and lower surfaces maculated with blackish.

Two specimens from the Timor Laut Islands.

XXVII.—*Neuroptera of the Hawaiian Islands*.—Part I.
Pseudo-Neuroptera. By ROBERT McLACHLAN, F.R.S. &c.

IN this and in the paper on Neuroptera-Planipennia that will follow it I propose to give the results of the working-out of two small collections formed by the Rev. Thomas Blackburn in the islands, combined with such information as had been previously obtained from a few species taken by Mr. G. F. Mathew, R.N., a few existing in the British Museum from the results of Captain Beechey's voyage, and some other sources. As Mr. Blackburn has now left the islands, after a residence in them of several years, it may be some time before another opportunity occurs for a still further examination of their insect productions.

A general summary will appear with Part II. of this paper.

In Part I. seventeen species are considered, viz. two of Termitidæ, one of Embidæ, two of Psocidæ, and twelve of Odonata (or dragonflies). The Ephemeridæ and Perlidæ are not represented; but I cannot believe they are totally absent.

The two Termitidæ are probable importations from America; so also may be the single species of Embidæ. Of the Psocidæ one is probably endemic, the other may be an introduction from America (but the materials are too small). Of the dragonflies (Odonata), one is nearly cosmopolitan; two others are North-American species of powerful flight, and probably endowed with migratory instincts; one rather large species of Libellulina is apparently endemic; the Agrionina are no doubt strictly endemic, and form the most interesting

(and at the same time most puzzling) feature of the Neuropterous fauna.

Termitidæ.

Calotermes castaneus, Burm.

Calotermes castaneus, Burm.; Hag. Monogr. p. 38.

Two examples, gummed on card (*Blackburn*, No. 18).

A widely distributed species in America, ranging from California to Chili. In the Hawaiian individuals the wings expand to about 33 millim., their colour pale (almost whitish), and in the posterior wings the median nervure originates at about the basal fourth of the subcosta. These points are mentioned as the species appears to be variable.

Calotermes marginipennis, Latr.

Calotermes marginipennis, Latr.; Hag. Monogr. p. 47.

Two examples, gummed on card (*Blackburn*, No. 11).

A species recorded from Mexico and California. The Hawaiian examples are of small size (expanse 20 and 25 millim. respectively), but they agree otherwise, especially in the median nervure being nearly equidistant between the subcosta and submedian.

Embiidæ.

Oligotoma insularis, n. sp.

Body entirely pitchy fuscous; mouth-parts inclining to reddish; clothed with fine whitish pubescence. Head gently convex above, with no discal depression. Eyes large, coarsely faceted, black. Antennæ fuscous, annulated with whitish at the sutures, more than 18-jointed (mutilated), basal joint short and stout, second still shorter but much thinner, the succeeding joints elongate, slender, obconical. Pronotum more than twice as long as broad, much narrower than the head, the sides slightly dilated in the middle, the anterior portion slightly narrowed; a transverse impressed line anteriorly before the margin. Meso- and metanota nearly equal, each much longer and broader than the pronotum. Anal styles long and slender (asymmetric), the joints nearly equal. Legs pitchy fuscous, clothed with whitish pubescence; trochanters, knees, and tarsi pale testaceous.

Wings narrow, pale fuliginous, the coalescent subcosta and radius dark fuscous; rest of the venation fuscous; sector simply furcate from about its middle in the anterior wings

(much sooner in the posterior), the radius confluent with its upper branch before the apex; apparently no costal nervules; three nearly equidistant nervules between the upper branch of the sector and the radius; five complete whitish vittæ, one placed in each of the principal areas.

Length of body (much extended) 7-8 millim.; expanse $11\frac{1}{2}$ - $12\frac{1}{2}$ millim.

Three examples, gummed on card (*Blackburn*, Nos. 12 and 19).

The Indian *O. Saundersii*, Westw., has the body testaceous.

A specimen in my collection from Antigua (*T. A. Marshall*) is so similar to *O. insularis* that I hesitate to separate it therefrom; this has been erroneously recorded as a *Man-tispa* (!) (*cf.* Proc. Ent. Soc. Lond. 1878, p. xxxiv).

Psocidæ.

Psocus, sp.?

One unexpanded specimen, on card, with the wings gummed together, appears to me incapable of identification. It is probably very close to the European *Ps. bifasciatus*, Latr. (also found in North America); and were it not for a difference in the markings of the head, it might (in its present condition) be considered identical therewith; perhaps even it is really that species. (*Blackburn*, without No.)

Elipsocus vinosus, n. sp.

(Body destroyed.) Antennæ (fragments) apparently blackish, slender. Legs pinkish (or very pale claret-coloured); tibiæ and tarsi with rows of minute black tubercles, the bases of fine short hairs.

Wings vitreous, scarcely tinged (under the microscope the membrane is seen to be studded with very minute closely-placed black points); neuration apparently reddish brown; pterostigma elongate, gradually dilated to the oblique apex, *bright claret-coloured*; posterior marginal cellule large, subtriangular, the apex rounded. In the posterior wings the neuration appears to be blacker.

Expanse about $4\frac{3}{4}$ millim.

One much mutilated example, gummed on card (*Blackburn*, No. 13).

N.B.—Nothing but the insular habitat, combined with the presence of apparently striking characters, could have induced me to bestow a name upon this mutilated specimen.

Odonata.

LIBELLULINA.

Pantala flavescens, F.

A nearly cosmopolitan species; found universally within the tropics (*Mathew, Blackburn, &c.*).

Tramea lacerata, Hagen.

A North-American species, extending to Mexico (*Mathew, Blackburn*).

Leptemis Blackburni, n. sp.

Wings quite hyaline, very shining, both pairs yellow (slightly olivaceous) at the base nearly or quite up to the triangles; this colour more intense and more extended outwardly in the subcostal and median areas, not extending to the anal angle in the posterior wings. Neuration entirely black, the costal nervure black outwardly. Pterostigma long (4 millim.), greyish yellow (brown when very adult), between thickened deep black nervules. Eleven or twelve antecubital and nine postcubital nervules in the anterior wings; a supernumerary nervule in the anterior wings (not in the posterior). Sectors of the arculus with a short petiole. Discoidal triangle in the anterior wings rather broad, traversed by one or, exceptionally, by two nervules; inner triangle with three cellules (in the posterior wings the discoidal triangle may be either free or traversed by a nervule; inner triangle absent or abnormally present); three rows of posttrigonal cellules. Membranule whitish cinereous. Posterior wings moderately dilated at the base. The network of all the wings fine and close.

Head: face pale yellow, clothed with erect black hairs; an isolated transversely oval shining black spot on the top of the front, and a broad band of the same colour in front of the ocelli; labium and a broad inner margin on each of the side lobes black; labrum black at its base and with a narrow black margin in the female (or with only the narrow black margin, male); occiput blackish, yellow behind; back of head shining black, with three yellow spots on either side, fringed with a strong crest of cinereous hairs.

Prothorax black (with an indistinct median yellow spot), its posterior lobe *very large*, slightly emarginate in the middle (hence indistinctly bilobed), with a median im-

pressed line, fringed with a long and thick crest of cinereous hairs.

Thorax deep opaque black above, clothed with cinereous hairs; an oval antehumeral isolated yellow spot on each side anteriorly, scarcely touching the anterior margin, and a transverse cuneiform yellow spot on each side posteriorly, margining the thoracic cavities, which are also yellow; interalar space spotted with yellow. *Sides of thorax metallic green*, with seven large yellow spots arranged in two series (three and four); posterior margin also yellow; pectus spotted with yellow.

Legs deep black (brownish in a somewhat immature example), long and slender; femora with only short spines, but with very long cinereous hairs; tibiae with long and close slender spinés; inner tooth of claws rather strong, placed not far below the apex.

Abdomen slender, greatly dilated at the base to the end of the third segment; second and third segments with a median suture. Colour bronzy black; second segment with a large median posterior brownish-yellow spot, divided anteriorly, third with a large median dorsal band of the same colour (in the male these dorsal markings are continuous with the pale sides, so that almost the entire segments are pale; in the female the dorsal markings and pale sides are separated by the black ground-colour); a small anterior brownish-yellow geminate spot on the fourth to sixth; on the seventh this spot enlarges and occupies nearly the whole of the dorsal portion of the segment, and on the eighth becomes small again, forming two small anterior lines (very indistinct in the male); ninth with two indistinct anterior points (obliterated in the male), and there is a small marginal point on the tenth.

♂. Genitalia of second segment concealed, but the side-pieces are long, obtuse, and finger-shaped, with a tuft of long cinereous hairs. Superior appendages as long as the last two segments, black, cylindrical, gently curved, the apical portion gently dilated, the apex oblique, very acute, and turned slightly upward; on the lower edge is a series of about eight small teeth or tubercles. Inferior appendage elongate-triangular, extending beyond the teeth of the superior, its apex emarginate with acute angles.

♀. Appendages not so long as the ninth segment, black, straight, cylindrical, somewhat dilated towards the apex, which is acute and prolonged; the inflated ventral tubercle densely clothed with cinereous hairs. Vulvar scale adpressed, flat, longer than the ninth segment, its apex semicircular and slightly outstanding.

Length of abdomen, ♂ 38 millim., ♀ 40 millim.; length of posterior wing, ♂ 38 millim., ♀ 39 millim.; expanse, ♂ 77 millim., ♀ 80-84 millim.

I have examined one male and two females (*Blackburn*, No. 16).

Mr. Blackburn says, "This dragon-fly is widely distributed, but not common. It occurs at various elevations from near the sea-level to at least 4500 feet. I have taken it on nearly all the islands." I think it must be considered a really indigenous species; at any rate I know of nothing like it.

The precise position of the species is perhaps open to doubt in the present uncertain state of the classification of Libellulina. At first sight it has somewhat the aspect of a *Dythemis*, but the large posterior lobe of the prothorax precludes any such affinity. In the form of the prothorax, slender abdomen with much inflated base, and general aspect it may be located in *Leptthemis* as that elastic genus is now constituted; it principally differs therefrom in the broader discoidal triangle of the anterior wing, in the longer and more slender tibial spines, and in the form and position of the inner tooth of the claws. There appears to be no other defined group with a similar prothoracic formation in which it can be placed.

ÆSCHNINA.

Anax junius, Drury.

This common North-American species (which has been also recorded from Kamtschatka and North China) appears to be general in the islands. In examining a series of American examples with regard to the anal appendages of the males, I find a certain amount of slight variation that may be partly individual, partly local, in its nature. In two Hawaiian males before me the inferior appendage appears to me to be distinctly shorter and more deeply excised in the middle than in the American specimens; even if this should prove to be constant, it is of no specific value.

Anax strenuus, Hagen.

Anax strenuus, Hagen, Verh. zool.-bot. Ges. in Wien, 1867, p. 34.

The type is a female taken during the Danish 'Galathea' expedition, and is in the Copenhagen Museum. It would appear to differ from *A. junius* principally in its greater size (expanse "136 millim.," as opposed to "95-112 millim." in *junius*) and in slight colour characters. Hagen considers the

discovery of the male necessary in order to establish the species with certainty.

Mr. Blackburn once informed me that he had seen (but was unable to capture) an *Anax* that appeared to be larger than *junius*.

AGRIONINA.

Agrion (?) *xanthomelas*, Selys.

Agrion (?) *xanthomelas*, Selys, Synop. Agrionines, légion *Agrion*, suite, p. 174 (1876).

Originally described from specimens found by Mathew. "Occurs near Wailuku, Maui" (*Blackburn*, No. 28).

Varieties.

1. The antehumeral reddish band narrower than in the type, strongly interrupted posteriorly into a point of exclamation, not connected posteriorly with the sutural band, and hence not furcate; a small median isolated black spot on the pale sides of the thorax. The blackish transverse band on the ninth segment broader.

2. *The postocular occipital line totally obliterated*, hence the top of the head is entirely black. Thoracic lines as in var. 1, and there is a large median isolated black spot on the sides of the thorax. Ninth segment with nearly its posterior half black above.

A male of each variety taken by Mr. Blackburn with the type form (also numbered 28), agreeing entirely therewith save in the points mentioned. The obliteration of the postocular line in var. 2 is important, considering the weight given to this character from a classificatory point of view; for my part I incline to the opinion that much undue weight is accorded to it, and that it is eminently artificial.

Agrion (?) *hawaiiense*, n. sp.

Wings hyaline, rather acute; neuration black. Pterostigma lozenge-shaped, surmounting slightly more than the cellule below it, brownish black, slightly paler at the edges. Quadrilateral having the superior edge about one third the length of the inferior in the anterior wings, one half in the posterior. Seventeen or eighteen postcubital nervules in the anterior wings, fourteen or fifteen in the posterior. Four cellules between the quadrilateral and the nodus.

Dark bronzy green.

Head black above, with isolated oval orange-yellow post-

ocular spots. Labium pale yellow. Labrum shining black, but its anterior margin broadly yellow (so that it is half black, half yellow); a broad yellow band occupies the vertical portion of the rhinarium; margins of the orbits in front broadly yellow; basal joint of antennæ yellow beneath, and there is a yellow spot below it; back of the head black.

Prothorax black, yellow at the junction with the head, with a large yellow spot above the anterior legs. In the male the posterior margin is gently rounded, with a minute median notch, narrowly yellow, which expands into a spot on either side. In the female the margin is thickened and broadly yellow, slightly elevated in its middle, with a distinct median notch in the centre of the elevated portion; in this sex there are two small round discal yellow spots (which are absent in the male).

Thorax bronzy green above. In the male there are four small yellow spots, two anterior and two posterior (with or without humeral lines); in the female there is a distinct narrow yellow humeral line, connected with the spots anteriorly but abbreviated posteriorly. Sides yellow, with a broad black median band, which is furcate towards the anterior wings and encloses a yellow spot. Pectus black, yellow in the centre.

Legs black, femora and anterior tibiæ yellow beneath; spines black, long and divaricated, seven or eight on posterior tibiæ.

Abdomen slender, bronzy green above, passing into yellowish at the sides and ventrally. First and second segments broadly yellow on the sides, enclosing on the first a greatly curved black line, which is nearly circular in outline; all the segments from the second to ninth with a narrow anterior yellowish sutural ring, which passes into obscure reddish on the apical segments; tenth segment nearly wholly obscure reddish.

♂. Margin of tenth segment broadly excised in the middle. Superior appendages slightly longer than the segment, nearly forcipate, stout, the apices curved inward and obtuse, divaricate, internally much dilated in more than the basal half beneath; black externally, the dilated internal basal portion reddish. Inferior appendages nearly one half shorter, elongately triangular, but gradually attenuate and nearly acute, turned upward and inward; black, but reddish at the base.

♀. Appendages short, black, conical. Valvules large, reddish, their appendages short.

Length of abdomen, ♂ 33 millim., ♀ 32 millim.; length of posterior wing, ♂ 23 millim., ♀ 24 millim.; expanse, ♂ 47½ millim., ♀ 51 millim.

"Oahu, at no great elevation above the sea" (*Blackburn*, two males, one female, No. 16).

The two males vary somewhat in the markings of the head and thorax. In one the postocular spots are nearly obliterated and bluish (instead of yellow or orange), and on the thorax the markings are also bluish, and the humeral lines are distinct, as described for the female, whereas they are wanting in the other. They are certainly specifically identical.

The precise location of this species must remain doubtful. On the one hand it approaches *Nehalennia* in its slender form and bronzy colour, but the anal characters of the male appear to preclude such a position; on the other hand, the long tibial spines would seem to indicate affinity with *Argia*.

Agrion (?) *pacificum*, n. sp.

Wings hyaline, obtuse; neuration black. Pterostigma lozenge-shaped, scarcely covering the cellule beneath it, reddish brown. Quadrilateral having its superior edge about one third the length of the inferior in the anterior wings, and fully half the length in the posterior. Twelve to fourteen postcubital nervules in the anterior wings, eleven in the posterior. Three cellules between the quadrilateral and nodus.

Dull black.

Head small, totally black above (*no postocular spots*). Labium and margin of labrum yellowish; orbits broadly yellowish (or greenish) exteriorly. Back of head black.

Prothorax having its posterior margin slightly and obtusely elevated in the middle in both sexes. In the male there are two approximate nuchal spots, two distant discal, and two very large, one on each side of the margin, orange or yellow. In the female the margin is also yellow on each side of the produced portion.

Thorax with no humeral lines, but with a yellow (or orange) humeral spot posteriorly. Sides with two broad yellow (or orange) bands—one superior and anterior, abbreviated at about the middle, but with a corresponding minute posterior spot; the other inferior and posterior, proceeding about halfway from the wings and then abbreviated. Pectus black.

Legs black; femora brownish beneath; spines long and divaricated, about six on the posterior tibiae.

Abdomen slender, black; a large reddish or yellow spot on each side of the first and second segments; eighth and ninth with a broad reddish anterior ring, and the posterior margin of the tenth narrowly reddish in the male (in the female these segments are wholly black), the ring on the ninth occupying nearly half the segment; ventrally the segments have a nar-

row yellowish longitudinal border (more conspicuous in the female).

♂. The tenth segment has a broad triangular excision on its border. Superior appendages black, very short, stout, obtuse, excised below the apex internally. Inferior appendages black, long, subforcipate, turned inward, very acute; more than twice the length of the superior.

♀. The appendages are very short, stout, conical, black. Valvules short, reddish varied with black, and with somewhat long black appendages.

Length of abdomen, ♂ 28½ millim., ♀ 25 millim.; length of posterior wing, ♂ 20 millim., ♀ 19 millim.; expanse, ♂ 41 millim., ♀ 38 millim.

"Lanai and Oahu, at various elevations" (*Blackburn*, two males, one female, No. 53).

Notwithstanding the entire absence of postocular spots or lines, I think this insect is allied to *A. xanthomelas*, on account of general (and especially anal) structure. Eliminating it from *Argia* (with which it has affinity on account of the long tibial spines), the absence of postocular spots would place it in *Erythromma*; but the small head, slender body, and anal characters are opposed to its location therein.

Agrion (?) *deceptor*, n. sp.

Wings hyaline (or with the faintest smoky tinge in the adult), rather acute. Pterostigma longer than broad, surmounting two cellules, reddish brown. Neuration black. Quadrilateral having its superior edge one third the length of the lower in the anterior wings, nearly one half in the posterior. Twenty or twenty-one postcubital cellules in the anterior wings, fifteen to eighteen in the posterior. Five cellules between the quadrilateral and the nodus.

Head and thorax black. Abdomen bright red.

Labium dingy yellowish. A broad border to the labrum, broad anterior orbits, a broad band above the rhinarium, and a small line on the basal joint of antennæ beneath, yellowish or reddish. Postocular spots narrow, reddish, connected by a line. Posterior margin of prothorax having the sides broadly dilated, but the dilated portion is interrupted before the middle, leaving the apex of the discal portion projecting somewhat obtusely between the two portions. Neck, a large median triangular spot, and the broad dilated portion of the posterior margin red.

Thorax with a broad red antehumeral band, interrupted posteriorly in a point of exclamation, red, followed by a broader black humeral band. Sides red with two yellowish

lines, and two black bands connected at the intermediate legs. Pectus black.

Legs red; spines black, those on the tibiae long and divaricate; apex of tarsal joints and tips of claws black.

Abdomen bright red, marked with black as follows:—A large quadrate spot at the base of the first segment, somewhat emarginate posteriorly, and a small spot on either side on the posterior suture; a narrow ring at the apex of segments 2 to 4; a broad ring at apex of segment 5; the whole of segments 6 to 8 (excepting a broad ring at base of 6 occupying about one sixth of its length, a narrow ring at apex of 7 and 8, and the sides of all three, broadly); a large irregular spot on each side of segment 9.

♂. The margin of tenth segment is very oblique on either side, and with a sudden small triangular median excision. Superior appendages longer than the segment, black (red at the base internally), stout, the apices slightly incurved; internally the basal portion is much dilated for more than half their length, and at the apex of the dilated portion is a slight excision, leaving a formation as of two indistinct blunt teeth. Inferior appendages scarcely one half shorter, slender, slightly incurved, red, blackish at the tips.

♀. Unknown.

Length of abdomen, ♂ 34 millim.; length of posterior wing 23 millim.; expanse 51 millim.

Oahu (*Blackburn*, one male, No. 67). Taken in company with *Megalagrion oceanicum* (*vide post.*), and sent by Mr. Blackburn under the same number. There is *very great* general resemblance; but the size, neural characters, &c. readily separate the two; the anal parts, although very similar, also present differences.

Agrion (?) *calliphya*, n. sp.

Wings narrow, tinged with yellow; *petiolated nearly up to the basal postcostal nervule in both pairs*. Pterostigma lozenge-shaped, surmounting rather more than one cellule, reddish brown. Quadrilateral elongate, its upper edge about half the length of the lower in both pairs. *Postpterostigmatical cellules irregular*, distinctly in two rows in the posterior wings. Sixteen or seventeen postcubital nervules in the anterior wings, thirteen or fourteen in the posterior. Four cellules between the quadrilateral and the nodus.

Head and thorax black. Abdomen red.

Front wholly reddish yellow, excepting a very narrow black line before the rhinarium. Postocular spots red, small, and nearly linear.

Prothorax having its posterior margin gently rounded and narrowly red (otherwise black).

Thorax with the very narrow dorsal crest, and a narrow, slightly curved, continuous antehumeral line red, the latter followed by a broad black humeral band; sides red, with two yellowish lines (whereof the upper exists as a vestige at the base of the anterior wings); a black spot, and a narrow black mesothoracic sutural line. Pectus red.

Legs red; spines black, those on the tibiae long and divaricate; apex of tarsal joints and tips of claws black.

Abdomen very slender, bright red; a large quadrate spot on the first segment, a narrow ring at the apex of the second to sixth (broader and expanding on the sides in the fifth and sixth), and an anterior lateral line on the seventh, black.

♂. The margin of the tenth segment is shallowly excised in a semicircular manner. Superior appendages longer than the segment, very stout, blackish, red at the base; the apex very obtuse and curved inward; internally they are greatly dilated at the base, with a sort of blackish basal tubercle. Inferior appendages shorter, red with black tips, cylindrical, curved inward, and with a basal internal ventral dilatation.

♀. Unknown.

Length of abdomen, ♂ 37 millim.; length of posterior wing $24\frac{1}{2}$ millim.; expanse 51 millim.

"Lanai, about 2000 ft." (*Blackburn*, one male, No. 55).

In some respects this is the most aberrant of the red Hawaiian species, owing to its narrow wings and their greater amount of petiolation; the anal parts are, however, quite homologous.

MEGALAGRION, n. g. (*Légion Agrion*.)

Inferior sector of the triangle originating before the basal postcostal nervule. Arculus continuous with the second costal nervule. Pterostigma lozenge-shaped, its lower edge shorter than the upper, surmounting two cellules. *Postcostal area with two rows of cellules*. Postocular spots present, large.

Labium excised for about a third of its length.

Form robust, especially in the female.

Spines of the tibiae long and strong; inner tooth of claws small.

Colour red.

No vulvar spine.

I have established this division for the reception of two of the most magnificent species of the *Légion Agrion* hitherto

discovered. The double row of cellules in the postcostal area (and in *M. Blackburni* the neuriation is still more irregular) exists only in *Hyponeura*, and the long tibial spines apparently show further affinity therewith; but the coloration is opposed, and the anal characters are in accordance with most of the other Hawaiian Agrionina.

Megalagrion Blackburni, n. sp.

Wings hyaline in the slightly immature male, tinged with fuliginous in the female. Pterostigma surmounting two cellules (or two and a half), its lower edge very distinctly shorter than the upper, outwardly very oblique, reddish brown. Neuriation black. Quadrilateral having its upper edge about one third the length of the lower in the anterior wings, about one half in the posterior (only about one fourth in both pairs in the female). A double row of postpterostigmatical cellules. Postcostal area with two complete series of cellules, and the inferior sector of the triangle is irregularly broken, so that there is a partially double series in the area between it and the superior sector. In addition to this the neuriation in the apical half of the wing is often broken up into double series of cellules, in some places simulating interposed sectors. Thirty postcubital cellules in the anterior wing, and twenty-three in the posterior in the male, thirty-six and twenty-seven in the female. Eight or nine cellules between the quadrilateral and the nodus.

Head and thorax black, abdomen bright red.

Labium yellow. Labrum broadly margined with yellow, and the orbits anteriorly are broadly yellow. Postocular spots very large, rounded, connected by a line, reddish (yellowish in the semiadult male).

Prothorax having its posterior margin rounded (slightly elevated in the male), marked with reddish (or yellow) as follows:—neck, two median spots (geminata), a discal one either side of these, a large external one on either side, and the posterior margin.

Thorax with a narrow reddish (or yellow) antehumeral line connected anteriorly with an inner spot, and dilated posteriorly in a triangular manner; median crest very narrowly reddish (or yellow). Sides reddish (or yellowish), with two oblique black bands, whereof the upper is abbreviated. Pectus black.

Legs red (yellow in the semiadult male) with black spines; apex of tarsal joints and tips of claws black.

Abdomen deep red (less intense in the semiadult male), marked with black as follows:—In the male there is a spot at the base of the first segment, a narrow posterior ring on segments

2 to 6, expanding on the sides of the sixth, on the seventh the apex is broadly black, which is continued laterally for nearly the whole length, a large spot on the sides of the eighth; in the female the apical rings are more distinct, and there is a subapical narrower ring on the second to fourth segments, fifth with a broad apical ring enclosing a transverse spot of the ground-colour, sixth with a very broad apical band which is trifid anteriorly, seventh and eighth wholly black except at the sutures, ninth black at its base.

♂. The tenth segment has a deep triangular excision on its margin. Superior appendages longer than the tenth segment; the lower dilated portion divided internally into two blunt teeth, whereof the upper is black; apical portion stout, incurved, obtuse, black. Inferior appendages more than half the length of the superior, cylindrical, the tips incurved and black.

♀. The appendages are very short, stout, conical, black. Valvules moderate, not reaching the extremity of the abdomen, red, their appendages (broken) black.

Length of abdomen, ♂ 47 millim., ♀ 42 millim.; length of posterior wing, ♂ 32 millim., ♀ 36 millim.; expanse, ♂ 69 millim., ♀ 74 millim.

"At the head of Wailuku valley, Maui" (*Blackburn*, one male, one female, No. 26).

In colour strikingly resembling *Pyrrhosoma minium*.

Megalagrion oceanicum, n. sp.

Wings hyaline. Pterostigma surmounting two cellules, very oblique on its outer edge, the lower distinctly shorter than the upper, reddish brown. Neuration black. Quadrilateral having its upper edge scarcely one fourth the length of the lower in the anterior wings, one third the length in the posterior. A single row of postpterostigmatical cellules. Postcostal area with simple cellules up to about the level of the nodus, afterwards a double series (neuration otherwise not complicated). Twenty-one or twenty-two antecubital nervules in the anterior wings, eighteen in the posterior. Five cellules between the quadrilateral and the nodus.

Head and thorax black. Abdomen bright red.

Labium pale yellow. A broad margin to the labrum, a spot on either side of it, the orbits anteriorly, the vertical portion of the rhinarium, a band above it, the lower side of the first antennal joint, all yellow. Postocular spots large, nearly connected by a line, reddish orange.

Prothorax having its posterior margin gently elevated and rounded; the neck, two median spots (geminata), a discal

spot on either side, the posterior margin, and a very large spot on either side continued along the margin, reddish orange.

Thorax with broad reddish-orange antehumeral lines, followed by a broader black humeral band which has a projection on its lower edge anteriorly. Sides reddish orange, with an appearance as of two yellow bands and with vestiges of two black lines. Pectus reddish, with two black spots.

Legs reddish; spines black, those on the tibiae long and divaricate; apex of tarsal joints and tips of claws black.

Abdomen bright red; a spot at the base of first segment, a narrow ring at end of second to fifth, a broad ring at apex of sixth (extended into a line on the sides), the whole of the seventh and eighth (except an apical ring and the ventral margins), black.

♂. The tenth segment is broadly and shallowly excised. Superior appendages longer than the tenth segment, divergent, black, red at the base, stout; the apices inturned and nearly uncinatate, broadly dilated at the base inferiorly, the dilated portion inturned and furnished with two black teeth, the lower small, the upper large. Inferior appendages one third shorter, slender, not divergent, acute, slightly incurved, gradually dilated to the base.

♀. Unknown.

Length of abdomen, ♂ 38 millim.; length of posterior wing 28 millim.; expanse 58 millim.

"Oahu, at no great elevation above the sea" (*Blackburn*, one male, No. 67).

The neururation in this species is much more regular than in *M. Blackburni*.

The Hawaiian Agrionina probably form a special group; but, excepting in the two large species, I have not considered it prudent to separate them from "*Agrion*" on account of the apparent impossibility of being able to give characters (other than geographical). In the whole of them the wings cease to be petiolated before the basal postcostal nervule (only slightly before in *calliphya*), the postocular spots are present (except in *pacificum*), and the female has no abdominal spine (i. e. in those species of which that sex is known). In most of them the tibial spines are long, but not as strikingly so as in *Argia*. And in nearly all of them (I might say actually in all) there is a striking similarity in male anal characters (reminding one, to some extent, of that which obtains in *Agrion Lindenii*, but with much longer inferior appendages).

XXVIII.—*Contributions to a Knowledge of Malayan Entomology*.—Part I. By W. L. DISTANT.

Order LEPIDOPTERA.

RHOPALOCERA.

Melanitis abdullæ, n. sp.

Wings above dark fuliginous brown, somewhat paler at outer margins. Wings beneath ochraceous, thickly mottled with brown; anterior wings with two broad and irregular dark fasciæ crossing cell and wing, some irregular waved markings beyond cell, and some small and indistinct ocellated spots placed in irregular series on outer discal area, of which the most distinct are two separated by the upper discoidal nervule, and two separated by the second median nervule; posterior wings with a narrow dark fascia passing a little beyond end of cell, beyond which the colour is uniformly darker and more opaque, and on which is included a series of six submarginal ocellated spots placed between the nervules, of which the second (situate above the discoidal nervule) and the sixth (placed near the anal angle) are somewhat the smallest. Body and legs more or less concolorous with wings.

Exp. wings 63 millim.

Hab. Malay peninsula, Province Wellesley.

This species is somewhat allied to the Ceylonese *M. tambra*, and the Javan *M. suyudana*, Moore, from both of which, beyond colour-differences on the under surface, it differs by the non-falcate apex of the anterior wings.

Tenaris Birchi, n. sp.

♂. Anterior wings above pale fuscous. Posterior wings greyish white, costal area to above the median nervules pale fuscous, with a large ocellated spot, of which the centre is blackish with a pale central eye, situate between the second and third median nervules, and which is broadly surrounded with ochraceous; a second very indistinct spot is situate on and above the lower subcostal nervule. Anterior wings beneath as above, but darker towards base. Posterior wings beneath as above, but with the basal area obliquely and not beyond the lower median nervule dark fuscous; the lower ocellated spot larger and brighter, the upper spot bright and concolorous but smaller, and situate on the subcostal nervules. Palpi ochraceous. Body dark obscure ochraceous.

Exp. wings 70 millim.

Hab. Singapore.

This species is allied to the Javan *T. Horsfieldii*, with a male of which, contained in the British Museum, my friend Mr. Butler has kindly compared it, and who writes me that it differs from that species by being "smaller, greyer in colour; the posterior wings have no blackish external border, and the upper ocellus is decidedly smaller. In some respects it is nearer to a species which we have from Borneo, but is smaller, has much smaller and less broadly zoned ocelli, and the dusky colouring on under surface of posterior wings confined to basal third instead of occupying half the wing."

This species was presented by J. K. Birch, Esq., of Province Wellesley, who captured it in Singapore, where he observed it flying whilst walking along a road. He writes, "Seeing it was a strange one, I knocked it down with a stick," thus not only securing an undescribed species, but for the first time proving that the genus *Tenaris* is found in the Malay peninsula.

Both this and the preceding species will be subsequently figured in my '*Rhopalocera Malayana*.'

Order RHYNCHOTA.

HOMOPTERA.

Pyrops javanensis, n. sp.

Head, pronotum, scutellum, and tegmina pale ochraceous, thickly but minutely spotted with black; tegmina also sparingly covered with larger reddish ochraceous spots, apex of scutellum unspotted. Wings creamy white. Body above fuscous, thickly covered with a white waxy pile, margins of segmental incisures ochraceous. Head, sternum, and tegmina beneath as above, the last paler; legs ochraceous, femora with a distinct black annulation near apex and an indistinct annulation between that and base; anterior and intermediate tibiae with about four black spots placed outwardly, the one nearest base more or less continued as an annulation beneath, posterior tibiae with five or six black spots placed outwardly, the sides of all the tibiae more or less finely black-spotted; tarsi with the apices of the joints more or less fuscous. Rostrum ochraceous, the apex pitchy and passing the intermediate coxæ.

Exp. tegm. 92 millim., long. cap. 24 millim.

Hab. Java.

This species is closely allied to *P. nobilis*, Westw., from

which it differs in the following particulars:—the prolongation of the head is not prominently and dentately spined, as in Westwood's species, but only obtusely spined, thus giving the head a much more slender appearance, the spines in both species being arranged in six longitudinal series, two above, two beneath, and one on each side; the black spotting is also much more minute, and the colour of the dorsal surface of the abdomen different.

I have received *P. nobilis* both from the Malay peninsula and Sumatra, whilst Java thus produces a distinct though closely allied species.

Pyrops mustelinus, n. sp.

Body and tegmina above and beneath ochraceous, the head, pronotum, scutellum, sternum, and tegmina minutely black-spotted; tegmina with the veins reddish ochraceous; anal appendage black, thickly margined with white pile. Wings pale creamy white, the veins pale ochraceous. Femora ochraceous, annulated with black near apex, and with a few small black spots between the annulation and base; tibiæ more or less black-spotted, tarsi with the apices of the joints more or less fuscous.

Exp. tegm. 55 millim., long. cap. $14\frac{1}{2}$ millim.

Hab. Java.

This species is allied to the Indian *P. punctatus*, Oliv., from which it differs by the much more prolonged head, the apex of which is not distinctly curved upwards, and which is also more spotted with black than in Olivier's species; the abdomen above is ochraceous, and not black, &c.

XXIX.—Notes on the Palæozoic Bivalved Entomostraca*.—

No. XVI. By T. RUPERT JONES, F.R.S., F.G.S., &c.

[Plates VI. & IX.]

I. *Some Palæozoic and other Bivalved Entomostraca from Siberian Russia.* (Pl. VI.)

IN the summer of 1882 Professor A. Karpinsky, of the Mining Institute at St. Petersburg, asked me to examine and report

* Notes No. XV. appeared in the Ann. & Mag. Nat. Hist. for November 1882, ser. 5, vol. x. pp. 358–360.

on some specimens of fossil Entomostraca which had been obtained from the Devonian, Carboniferous, and Rhætic (?) formations of the Ural (eastern). Referring to the specimens the Professor observed :—"Toutes ces espèces étaient jusqu'à présent inconnues dans les sédiments de l'Oural ; la plupart de ces fossiles ne pourraient être trouvés que par les explorations souterraines à profondeur de quelques pieds."

1. *Estheria minuta* (Alberti), var. *Karpinskiana*.
(Pl. VI. figs. 1 a, 1 b.)

These specimens of an *Estheria*, labelled "No. 1. *Estheria*, Ural, District Troizk, Triassic or Jurassic (Rhætic ?)," are imbedded in a somewhat ferruginous and slightly calcareous shale, rather hard, and breaking into irregular pieces. The *Estheriæ* have been squeezed out of shape in one direction or another; but the most perfect shows the outline given in Pl. VI. fig. 1 a, in size about 4 millim. long by 3 millim. high. Some slight carbonaceous relics of the valves remain here and there.

All the specimens in the pieces of shale appear to belong to one species. The shape most nearly approaches that of *E. minuta*, Monogr. Foss. *Estheriæ*, Pal. Soc. 1863, pl. ii. fig. 5, where the dorsal joins the anterior margin with a simple convex curve without any depression in front of the umbo. As to size, however, these are smaller than *E. minuta* and rather larger than *E. minuta*, var. *Brodieana*, Jones (*ibid.* fig. 9), and much larger than some specimens of this variety (*ibid.* figs. 12 and 14).

Some trace of ornament remains on portions of the black film representing the valves, in the form of minute, irregular, vertical, wavy corrugations between the concentric ridges (fig. 1 b). A modification of such reticulation as occurs on some specimens of *E. minuta* might produce this appearance.

This *Estheria*, from the eastern side of the Ural, may be regarded as a variety of *E. minuta* (var. *Karpinskiana*), but whether Triassic or Rhætic, or even Jurassic, in age remains doubtful. The note which Prof. Karpinsky attached to the specimens is as follows :—

"No. 1. Les Esthères, qui peut-être ne présentent qu'une variété d'*Estheria minuta*. Ces Esthères se trouvent sur le versant oriental de l'Oural dans les sédiments d'eau douce avec les restes des plantes mal conservées, qu'on peut déterminer comme les espèces jurassiques—*Asplenium whitbyense*, var. *tenuis*, *Podozamites lanceolatus* et *Phyllothea striata*."

2. *Entomis serratostrata* (Sandberger) (Pl. VI. figs. 4, 5)
and *E. gyrata* (Richter) (Pl. VI. figs. 3 a, 3 b).

Several impressions and casts of different sizes in a light brown and somewhat schistose shale, labelled "No. 2. *Entomis*, Oural, Upper Devonian," represent *Entomis serratostrata* (see Ann. & Mag. Nat. Hist. ser. 5, vol. iv. 1879, pp. 183 &c. pl. xi. figs. 1, 5, 7, 13, and 14) and *E. gyrata* (*ibid.* figs. 4, 8, 10, 11, and 12) of the same geological formation.

Pl. VI. fig. 5 shows a small convex cast of a delicately striated valve of *E. serratostrata* (.75 millim. long), probably shortened by pressure. Fig. 4, also *E. serratostrata* (1 millim. long), is a convex cast of a middle-sized or ordinary ovate-oblong valve, with fine but rather coarser striæ. In some of the associated examples in the same schist the striæ are thicker than in the foregoing, are more flexuous, and show an inosculation here and there. These features are traceable in fig. 13, pl. xi. Ann. & Mag. Nat. Hist. (*loc. cit.*). In some also there are indications of the former existence of prickles, namely rows of minute pits accompanying the striæ.

In Pl. VI. fig. 3 we have a concave impression of the largest kind of valve (1.75 millim. long), with coarser striæ. These are more definitely concentric (that is, meeting at the ends), and are strongly marked with the little pits which indicate the places of prickles on the original surface. The specimen of *E. gyrata* figured in the Ann. & Mag. Nat. Hist. *loc. cit.* fig. 4 a ($\frac{18}{1}$) and fig. 4 b ($\frac{70}{1}$) nearly approximates to this and some others of the Ural specimens.

M. Karpinsky's note attached to these specimens is as follows:—

"No. 2. *Entomis* semblable à *Entomis serratostrata*. Ces fossiles proviennent du versant oriental de l'Oural, où ils se trouvent dans les couches dévoniennes supérieures avec *Cardiola retrostrata* et quelques *Goniatites* semblables à *Goniatites retrorsus*, mais très mal conservés."

2 a. In a very fine-grained and drab-coloured sandstone, labelled "No. 2 a," there are some small hollow impressions (external moulds) of the ordinary *E. serratostrata*, and these are accompanied by two minute convex casts (or remnants of valves) of doubtful alliance.

One of them (fig. 6), rather grey in colour and .90 millim. long, is somewhat like a *Leperditia* in outline, and has a rough pimply surface, and may possibly be a rugose *Primitia*.

Fr. Schmidt's *Leperditia Mælleri* (Misc. Silur. iii. pp. 23 Ann. & Mag. N. Hist. Ser. 5. Vol. xii. 18

and 88, pl. i. figs. 23-25, and pl. v. *a*, figs. 23 and 24) is rugose or pimply; but its larger size and difference in shape do not allow of further comparison with this minute rugose Leperditoid *Primitia* (?).

Fig. 7 is also a minute convex internal cast (.90 millim. long), the outline of which is not well exposed; and it has a roughly pitted or coarsely reticulated surface, as if the matrix were still adherent between pimples or little pustules, like those of fig. 6; and it is probably of the same species.

These in some degree resemble the granulate variety of *Primitia cylindrica* (*Beyrichia*, Richter), Zeitsch. d. d. geol. Ges. vol. xv. 1863, p. 671, pl. xix. fig. 12, from the Upper Silurian schists of Thuringia*, but not that treated of, *ibid.* xvii. p. 365, pl. x. fig. 7, which seems to me to be quite another kind of organism (see Geol. Mag. dec. 2, vol. viii. p. 342).

A small spinose or rugose Entomostracan has been noticed by Richter, namely his *Cythere spinosa*, from the Lower Carboniferous or "Culm" of Thuringia (Zeitsch. deutsch. geol. Ges. vol. xvi. 1864, p. 161, pl. iii. fig. 2); but this differs too much from the little Devonian fossil before us to allow of any approach to identification.

3. *Estheria striata* (Münster), var. *tenuispectoralis*, nov. (Pl. VI. fig. 2.)

In a very fine-grained, soft, grey, sandy shale, full of minute carbonaceous specks, and labelled "No. 3. *Estheria*, sp., Oural, Kamensk, Lower Carboniferous," is a delicate impression, or flattened cast, of a subovate *Estheria*, 5 millim. long by 4 millim. high. Its straight back is not quite perfect at the two ends; but its umbo was evidently close to the antero-dorsal end, as in *E. striata* and some others. In this feature, and in the bold oblique curve of the postero-ventral margin, this form markedly approaches *E. striata* (see Monogr. Foss. Esth., Pal. Soc. 1863, p. 23, pl. i. figs. 13 and 15); but it slopes too much, and is not full enough, on the antero-ventral margin, to exactly match any of the forms of that species. It is of the same size as the small, but suboblong. variety of *E. striata* figured *ibid.* fig. 18. Nor does it come close enough to *E. tenella* (Jordan), *ibid.* fig. 26, in the relative fulness of the front margin, nor even to *E. Peachii*, Jones, another Carboniferous species (Geol. Mag. vol. vii. 1870,

* The Thuringian *Beyrichia* figured and described without a locality in the Geol. Mag. dec. 2, vol. viii. pp. 342, 343, pl. x. figs. 1-6, are from the *Nereite*-beds at the Gräfenenthal and Steuach, near Saalfeld.

p. 220, pl. ix. fig. 17), to which otherwise it has a strong likeness.

Unfortunately even the concentric ridges are only imperfectly preserved, and no interstitial ornament is at all visible on the mere film remaining where the valve was imbedded.

Being inclined to regard it as a variety of the widely distributed *E. striata*, I propose to distinguish it as var. *tenuipectoralis*.

Prof. Karpinsky labelled it as follows:—"No. 3. *Estheria*, sp. Exemplaire unique trouvé près de l'usine Kainensk (Ural, versant oriental) dans les couches carbonifères inférieures contenant de la houille."

Imperfect as these foregoing determinations of East-Uralian fossil Entomostraca are in some respects, still the recognition of so many forms closely allied to species well known in Western Europe is of considerable interest to geologists and biologists; and our thanks are due to our fellow-worker at St. Petersburg, Prof. A. Karpinsky, for the opportunity of comparing these rare Russian specimens with those which we know so well in Germany, France, and England.

II. Some Palæozoic Bivalved Entomostraca from Spitzbergen. (Pl. IX.)

In the winter of 1882-3 my friend Dr. Gustav Lindström wrote to me from Stockholm, stating that Dr. Nathorst had recently returned from Spitzbergen with a rich harvest of fossils, and that amongst them he had brought home what the palæontologists at Stockholm recognized as

1. *Leperditia* in argillaceous schist of Devonian age from Klaas Billen Bay. Some small fragments of placodermatous fish-remains are also present.

2. *Estheria* in a dark-coloured, micaceous, and carbonaceous shale (labelled "Mimers dal" and "Mimers dal midten"); the greater part thinly laminated, with black Estherian films crowded on the planes of bedding; and some pieces more solid, rather lighter in colour. In these latter, which are chiefly marked "Mimers dal midten," an occasional hard carbonaceous nodule (coprolite) appears.

3. Accompanying the above there was a specimen of reddish limestone (waterworn), labelled "Liebde Bay, North-polar Expedition, 1868," which contains numerous *Leperditia*.

1. The *Leperditia* in the soft schist, or schistose mudstone, from Klaas Billen Bay are very numerous (see Pl. IX. figs. 1-8). They are all casts and impressions in the schist, lying at various angles to the original bedding, often crumpled

up, and nearly always either shortened or lengthened, as the case may be, by the lateral pressure to which the rock has been subjected. In some pieces of the schist the rough and imperfect cleavage gives faces at an angle of about 50° with the bedding.

The casts, however modified in shape, appear to be referable to only one species of *Leperditia*. The original shape seems to have been nearly oblong, with almost equally rounded ends, equably convex in the middle, and broadly rimmed all along the front, ventral, and hind margins. The ocular spot and nuchal furrow are generally recognizable. The best preserved of the internal casts is 15 millim. long, and 10 millim. high; another is 20 millim. long, by more than 10 millim. high (broken); and another 21 millim. long and 13 millim. high. The relative convexity of these carapace-valves is difficult to determine. There is no trace of radiate or other marking on the casts of the valves.

In the single hand-specimen of limestone from Liebde Bay, Spitzbergen, there are several imbedded *Leperditiae*, similar in shape to the best of the foregoing from Klaas Billen Bay, but not distorted by pressure. Though they retain their shape they are, for the most part, too much imbedded to be fully seen. The best individual is shown in Pl. IX. fig. 9 a. It is 10 millim. long by 6 millim. high; and though smaller than those in the schist, is probably of the same species. The ocular tubercle is higher up in the antero-dorsal region, with the nuchal furrow just behind it. Muscular spot not especially indicated. Sections of the carapace in the water-worn block are shown in figs. 9 b and 9 c.

In outline this species from Spitzbergen somewhat resembles *Leperditia Nordenskjældi*, Fr. Schmidt (Mém. Acad. Impér. Sc. St.-Pétersb. sér. 7, vol. xxxi. no. 5; Misc. Silur. iii. p. 25, pl. i. figs. 29-32); but it is more broadly oblong, being relatively higher, more equally rounded at the ends, and it has a broader marginal rim. As this last is very wide, the species seems at first sight to belong to *Isochilina*; but as there is a slight inflection of the ventral edge of one valve under that of the other, we must refer it to *Leperditia*. It may be named *Leperditia isochilinoides*.

2. The *Estheriæ* in the carbonaceous shale from Mimms dal are all crushed flat on the bed-planes, and are radiately crumpled by the minute folds of the depressed (formerly convex), thin, toughish valves. The black film retains, however, sufficient indications of the concentric ridge-lines, and frequently some trace of the interstitial sculpturing. In shape these valves are nearly semicircular, but the curvature has a general

oblique direction backwards and downwards, making the ventral region full behind. The umbo, or starting-point of the concentric ridges, is just within the anterior third of the dorsal region, and therefore at some distance from the antero-dorsal angle. In these characters this *Estheria* approaches such a form as the small *E. Forbesii* figured in the Monogr. Foss. Esth. pl. iv. fig. 10; but it does not exactly match any that I know of. It is too sharp anteriorly, and too long and broad from the front angle to the hinder ventral margin, for *E. tenella* (*ibid.* pl. i. fig. 26), to which, though larger, it otherwise bears some resemblance.

The ornament of the interspaces between the numerous concentric lines of growth consists of very fine dots, or punctation, like that in *E. striata* (*ibid.* pl. i. fig. 24); and, indeed, that of *E. tenella* is not very different (*ibid.* pl. i. fig. 27, and pl. v. fig. 7). This interesting palæozoic *Estheria* from Spitzbergen may well bear the name of its discoverer and be known as *E. Nathorsti*.

EXPLANATION OF PLATES VI. & IX.

PLATE VI. Fossil Entomostraca from Siberia (Eastern Ural).

- Fig. 1. *Estheria minuta* (Alberti), var. *Karpinskiana*, nov. *a*, left valve, magnified 7 diam.; *b*, portion, magn. 50 diam. The dorsal line should have been horizontal.
- Fig. 2. *Estheria striata* (Munster), var. *tenuispektoralis*, nov., magn. 7 diam.
- Fig. 3. *Entomis gyrata* (Richter). *a*, hollow impression of a valve, magn. 20 diam.; *b*, portion, magn. 50 diam.
- Fig. 4. *Entomis serratostrata* (Sandberger). *a*, convex cast of left valve, magn. 20 diam.; *b*, portion, magn. 50 diam.
- Fig. 5. The same. Convex cast of a small valve, magn. 20 diam.
- Fig. 6. *Primitia* ? Convex valve or cast, magn. 20 diam.
- Fig. 7. The same (?). Convex valve or cast, magn. 20 diam.

PLATE IX. Fossil Entomostraca from Spitzbergen. Figs. 1-8 from Klaas Billen Bay.

- Fig. 1. *Leperditia isochilinoidea*, nov. sp. Left valve, nat. size. This is one of the best preserved in shape, but has probably been somewhat narrowed in front by oblique pressure.
- Fig. 2. The same. Obliquely squeezed; right (?) valve, nat. size.
- Fig. 3. The same. Much squeezed obliquely; right valve, nat. size.
- Fig. 4. The same. Small left valve, narrowed by pressure, magn. $2\frac{1}{2}$ diam.
- Fig. 5. The same. Left (?) valve, narrowed and crushed by oblique pressure, nat. size.
- Fig. 6. The same. In a block, variously squeezed, nat. size.
- Fig. 7. The same. In a block, squeezed endwise &c., nat. size.
- Fig. 8. The same. Hollow cast, with remnant of a valve, nat. size.
- Fig. 9. The same. *a*, right valve, from Liebbe Bay, magn. $2\frac{1}{2}$ diam.; *b*, longitudinal section of a bivalved carapace, magn. $2\frac{1}{2}$ diam.; *c*, oblique transverse section near the end of another specimen, magn. $2\frac{1}{2}$ diam.
- Fig. 10. *Estheria Nathorsti*, nov. sp., from Mimms dal. *a*, right valve, flattened, magn. 5 diam.; *b*, portion, magn. 50 diam.

XXX.—On *Guard-Polyps and Urticating Cells*.

By Dr. R. VON LENDENFELD *.

I. *The Guard-Animals of the Plumularidæ.*

The Plumularidæ are distinguished, above all other Hydroids, by the fact that a great part, up to five sixths, of all the animals of a colony are converted into guard-polyps without stomachs. Busk † was the first who accurately described the chitinous calices in which the armed animals are seated, and directed attention to these structures, which he called *nematophores*. Subsequently Allman ‡ published some observations upon the contents of these nematophores, in which he sometimes found urticating capsules, sometimes not. He states that, leaving out of consideration the urticating capsules, the whole contents consist of structureless protoplasm, which emits long pseudopodia and retracts them again. Hincks § confirms Allman's statements, and carries the analogy of the contents of the nematophores with Rhizopoda still further, assuming, like Reichert, for the whole ectoderm of the Hydroids a *Bathybius*-like ground-mass in which urticating capsules are seated.

Although F. E. Schultze || as long ago as 1872 demonstrated the cellular structure of the ectoderm of the Hydroids, it is only quite recently, by the researches of Hamann ¶, that we have attained to a more exact insight into the finer structural characters of the guard-animals. Hamann explains the contents of the nematophore as a modified polyp, for which he proposes the designation "*machopolyp*." I adopt this view, and consider that the expression "nematophore" should be reserved for the chitinous envelope of the guard-polyp. Hamann has demonstrated muscle-cells in the greatly protrusible guard-polyps; and there is no doubt that the movements of the guard-polyp are in part effected by these muscles. I say in part, because the parallel fibres, which lie in one bundle, can only effect the retraction of the guard-polyp, while its protrusion is produced by other structures.

* Translated by W. S. Dallas, F.L.S., from the 'Zeitschrift für wissenschaftliche Zoologie,' Band xxxviii. pp. 355-370. The author's third communication "Ueber Cœlenteraten der Sudsee."

† Hunterian Lectures, 1857.

‡ Ann. & Mag. Nat. Hist. ser. 3, vol. xiii. (1864) p. 203.

§ British Hydroid Zoophytes, p. xvii (note).

|| Cordylophora, p. 15.

¶ Jenaische Zeitschrift für Naturwissenschaft, Bd. xv. p. 17.

The richness of the South-Australian shore-fauna in Plumularidæ is extraordinary. I have seen about forty different forms, the skeletons of which are in part already described. I have examined most of them in the living state, and would here communicate some observations which I have made upon their guard-polyps.

Notwithstanding the extraordinary variety which we meet with in their number and arrangement and in their form and size, they can all be referred to three fundamental forms, which often occur together upon the same stock :—

1. Guard-animals with urticating capsules.
2. Guard-animals with adhesive cells.
3. Guard-animals with urticating capsules and adhesive cells.

1. *Guard-Animals with Urticating Capsules.*

The guard-animals with urticating capsules occur chiefly upon the *Plumularia*-like Hydroids; they agree with the figure given by Hamann*.

The solid endodermal axis consists of elements like those of the tentacular axis, and extends to the middle of the guard-animal. The endoderm of the branch upon which the guard-polyp is seated passes directly into the endoderm of the latter. The cells which form the inner lining of the coenosarcial tube of the branch are turbid and completely filled with granules. The nearest endodermal cells of the axis of the guard-animal are also turbid and entirely filled with plasma. It is only at some distance from the branch that the axial cells begin to acquire more the form of chorda-cells, such as characterizes the cells of the tentacular axis; but the endodermal cells of the machopolyps, even in the distal part of the axis, are much more turbid and rich in plasma than the corresponding structures in the tentacles. In the contracted state they are quite opaque.

The ectoderm is highly developed, and consists of two layers, an epithelial and a subepithelial layer. The surface-cells appear cylindrical when the machopolyp is contracted; on the contrary, they are depressed and flat when the guard-animal extends itself. These surface-cells are for the most part entirely filled with plasma; they occur upon the whole basal part of the guard-animal. Between them and the thin supporting lamella, which is closely applied to the endodermal cells, there is a layer of smooth muscular fibres, which do

* 'Der Organismus der Hydroidpolypen,' pl. xxv.

not belong to the surface-cells, but are decidedly subepithelial. In isolation-preparations it is easy to detect the muscular corpuscles in the isolated fibrillæ; they lie between the centripetal ends of the surface-cells, and consequently may be called interstitial cells.

The muscular fibres form a cylindrical tube by lying in a parallel position upon the supporting lamella. When the guard-polyp is contracted they lie in a straight line and longitudinally. At the extremity of the endodermal axis the muscular cylinder also terminates, and there are here in the subepithelial layer from two to four fine large multipolar ganglion-cells. In the superficial layer of the whole terminal portion of the machopolyp we find large elongated urticating capsules. Each urticating capsule is enclosed by a thin plasma-envelope; the centrifugal end alone seems to be free. In this plasma-envelope there is a flat nucleus. The cnidocil is short and forms an angle of 60° with the surface; it is always situated opposite to the nucleus. Sometimes it is slightly bent, and then the concave side is always turned towards the urticating capsule.

The centripetal end of the plasma-envelope is drawn out into a process which lies radially and always appears to be straight. All these processes unite at the centrifugal extremity of the endodermal axis; therefore at the same place where the ganglion-cells are situated. Further, there are also in the terminal knob of the guard-animal radial muscular fibres, which are sometimes closely applied to the pedicles of the cnidoblasts. Supporting cells with broad centrifugal terminal lamellæ also occur. Some of the superficial cells are remarkable for their slenderness, and may be interpreted as sense-cells. I have not succeeded, however, in detecting any connexion of these cells with the subepithelial ganglion-cells, so that I am not sure whether or not these elements perform a tactile function.

The guard-polyps are capable of extraordinary extension in length, which, however, takes place slowly, like the extension of the tentacles of *Hydra*, and never shows that precision and rapidity of movement which characterize the solid tentacles. The retraction of the guard-animal takes place much more quickly; it may be effected in half a second. The movements of the extended guard-animal are inconsiderable and really amœboid.

Both the extension and contraction and the movements which are performed in the extended state may be easily recognized as the effects of two antagonists. Just as in the tentacles, we have here to do with an elastic rod on all sides

of which longitudinal muscles are applied. That the extension does not take place so rapidly as in the tentacle is easily explained by the fact that the axial cells of the guard-polyp have not attained the same degree of differentiation as the chorda-cells of the tentacular axis. This is certainly to be accounted for by the fact that the tentacles are phylogenetically much older structures than the machopolyps, and consequently their axial cells had a much longer time to adapt themselves to their new purpose than the endodermal cells of those polyps which became transformed into guard-animals.

If we start from a *Protohydra* with hollow tentacles and consider its transformation into the guard-polyp of a *Plumularid*, we meet with a gradual suppression of the gastral space. First of all the tentacles become solid; then the stomachal walls grow together. Centralization of the gastral space first of all in the person and then in the stock.

The machopolyps are certainly employed as defensive weapons, as they do not retract themselves when the polyp-stock is touched; on the contrary, they protrude themselves from their chitinous calices when the branch upon which they are seated is separated from the stock.

How far the guard-animals with urticating capsules in the nematophores of many *Plumularia* also act offensively I could not ascertain; but these, as well as the machopolyps with adhesive cells, hereafter to be described, may be employed in the capture of prey. In all species of *Plumularia* that I have investigated the urticating capsules at the centrifugal extremity of the guard-polyp remained always at the apex of the animal, and consequently accompanied it in all its movements. I must particularly insist upon this in opposition to Allman's statement*. Allman concludes, from his observations upon certain *Plumulariæ*, that "the clusters of thread-cells, when they exist, remain quite stationary, being never carried out with the sarcode in its pseudopodial processes." I think that I can demonstrate that this observation relates to another fact than Allman supposes; and I am sure that in all cases that I have observed, when urticating capsules and no adhesive cells occurred upon the machopolyp, the urticating capsules were never left behind in the movements of the animal.

2. Guard-Animals with Adhesive Cells.

The animals which belong to this category occur principally in those nematophores of the species of *Aglaophenia*

* 'A Monograph of the Gymnoblastic Hydroids,' vol. i. p. 116.

which are placed in front of the nutritive animals. Further, they may sometimes occur in the genus *Antennularia*. In other Plumularidæ, which, on account of their peculiar gonophores, will necessitate the establishment of a new genus, I have observed such machopolypts together with guard-animals bearing urticating capsules. They do not differ essentially in their structure from those above described. The greatest difference is that *instead of urticating capsules they possess adhesive granules which are exactly similarly formed to the corresponding elements in the tentacles of the Ctenophora*.

The adhesive animals, as I will briefly designate these machopolypts, are distinguished by their extraordinary mobility. If an occasional change of form is possible to the urticating guard-animals, the adhesive animals can entirely draw themselves out into long fine threads, at the extremity of which there is then a bulbous dilatation, which on its part is capable of considerable change of form.

In these guard-animals we can detect surface-cells, sub-epithelial muscles and ganglia, the supporting lamella, and endodermal axis. The thickened terminal part consists of pyramidal cells radially arranged, all, or the greater part of which, produce adhesive granules. Thus we find in each of them a rounded drop of a strongly refractive substance; and by this means these cells acquire exactly the appearance of gland-cells. The drop originates at the narrowed centripetal end as a small vacuole, and migrates during its growth towards the widened centrifugal end of the cell. The perfect adhesive granule attains nearly the diameter of the free surface of its formative cell and is globular; it projects pretty far above the surface of the terminal enlargement of the guard-animal. Such mature adhesive granules generally occur in considerable number; but they do not stand so close together as on the surface of the prehensile apparatus of the Ctenophora, and never show that regular arrangement which Chun figures* in *Euplocamis stationis*. The great similarity between our guard-polyps and the prehensile filaments of the Ctenophora strikes one at once. The difference consists essentially only in the fact that the filaments themselves in the Plumularidæ are not spirally rolled up. We shall revert further on to the analogy of these weapons. Allman † figures an *Antennularia* the guard-animals of which are branched. In those Australian species of that genus which contain only machopolypts with adhesive cells, I have only met with ramifications when cer-

* 'Die Ctenophoren des Golfes von Neapel,' pl. xviii. fig. 11.

† 'A Monograph of the Gymnoblasic Hydroids,' vol. i. p. 118.

tain adhesive granules remained adherent to any object which could not be drawn nearer, and then, during the contraction of the guard-animal, the thickened terminal part was much drawn out in length. If then another part of it adhered to some other object and the machopolyp contracted still further, it sometimes acquired, in a certain sense, a ramified form.

These guard-polyps are exclusively offensive in their action. If the polyp-stock be disturbed they retract themselves into their chitinous calices. I can completely confirm Allman's statement*, that the "pseudopodium-like processes" are visible only on perfectly fresh stocks, as regards the adhesive polyps; and I believe that the statements of Allman and Hincks relate principally to these adhesive polyps. We shall recur to their function further on.

3. *Guard-Animals with Urticating Capsules and Adhesive Cells.*

These machopolyps are found exclusively in the genus *Aglaophenia*; and here they occur in those nematophores which are placed behind the nutritive animals and project beyond these. I call them paired superior guard-animals.

For our investigation some species of *Aglaophenia* with large superior guard-animals which are abundant here (Melbourne) are admirably adapted. The nematophores which contain these machopolyps have, besides the circular orifice at the extremity, also an oval aperture at the side; this is placed towards the nutritive animal, at the spot where the chitinous calice of the nutritive animal terminates, on the concave anterior side of the nematophore which is turned towards the nutritive polyp. In these nematophores are seated guard-polyps which are composed of two parts. In the distal extremity, close under the terminal orifice, there are urticating capsules; while from the proximal aperture a filament can be extended, at the extremity of which there is an adhesive knob. The distal part resembles an animal armed with urticating capsules, while the proximal part is to be compared to an adhesive animal.

Of the former, however, only that part is developed which represents the distal part of an animal armed with urticating capsules, such as I have described above. There is no endodermal cellular axis, and therefore also no supporting lamella. But ganglion cells occur in the subepithelial layer; and between the cnidoblasts there are radial muscles and supporting

* *Loc. cit.* p. 115.

cells, and perhaps also sense-cells. This part of the guard-animal, the muscular stem being deficient, is not very mobile, and it is protruded only for a short distance from the terminal orifice of the nematophore. In the basal part of the nematophore there is a second head, which exactly resembles an adhesive polyp; its thickened extremity can be protruded far out of the inferior aperture of the nematophore, and it possesses an endodermal axis.

Although at the first glance the whole rather gives us the impression that we have to do here with *two* modified polyps, the simple undivided endodermal axis indicates that the whole is homologous with *a single* polyp. If we trace the development of these guard-animals we see distinctly that both pieces are parts of an originally simple armed polyp. Thus the end of the branch always forms a pair of guard-polyps; long before the nutritive animals in front of these have become developed, the next pair of machopolyps sprouts. At the ends of the branches of young stocks we can find all stages; and in this way it is easy to trace the development.

Young guard-polyps of this kind are inserted in chitinous calices, the hinder margin of which is somewhat higher than the anterior margin; they are completely filled with urticating capsules and tolerably mobile, so that they can stretch forth their mitrailleur-like heads for a considerable distance. While no chitine is secreted at the anterior side, the hinder margin grows very rapidly. In this way the nematophore acquires the form of a very obliquely truncated straight circular cylinder. Then the chitine secretion ceases at the lower part of the elliptical margin, while the uppermost part grows in all directions, and its margins finally unite again into a tube. This tube then elongates, and in some *Aglaopheniæ* bends outwards in a hook-like form.

In some instances the formation of two apertures is not attained; and then the nematophores possess a wider or narrower cleft, which unites the two apertures. This applies without exception (?) to those nematophores which are closely applied to the upper surface of the nutritive animal in the plane of symmetry of the branch, the unpaired, superior machopolyps.

Even when the two apertures are separated, when a nutritive polyp is in course of formation in front of the nematophore, and the buds of the next pair of guard-animals are already indicated, no adhesive cells are yet to be met with; there is rather an urticating battery behind each aperture. It is only subsequently that small drops begin to appear in the supporting cells between the cnidoblasts of the lower

battery; and these in older guard-animals attain the form and size of adhesive granules. At the same time the number of cnidoblasts diminishes, the urticating capsules falling out and the plasma-envelopes degenerating. Frequently, however, a few urticating capsules are found even later in the head of the prehensile filament, and these are not thrown off until very late. In the older parts of the stock they never occur.

Allman states* that in some Plumularidæ, and especially in *Antennularia*, the nematophore is divided into two stories by a diaphragm. I can confirm this statement for the Australian *Antennularia*; and add that in many (perhaps all?) species of *Aglaophenia* also such a diaphragm is more or less developed in the paired superior nematophores.

The division of the body of the nutritive polyps of the Plumularidæ into an oral and an aboral half, which is caused by a considerable circular constriction in the middle of its length, has already been described by Hamann†. His statements apply also to the Australian species. The division of the large guard-polyps into a distal defensive and a proximal offensive half seems to me to indicate that in this case the centripetal part is homologous with the aboral and the centrifugal with the oral part of the nutritive animal.

I have frequently had the opportunity of tracing in the living animal the mode of action of the armed animal, and will here give the most important points. The *Aglaophenia* live principally upon zoæ and other larvæ. If a zoëa comes in contact with a tentacle it is struck by several cnidocils and makes vehement movements in order to escape. These efforts, however, are fruitless, which I would ascribe to a numbing action of the nettling threads. As soon as the zoëa has touched the tentacle, all the prehensile threads (there are five of them) belonging to the particular polyp bend and stretch themselves towards the spot. Usually the zoëa at the same time touches the adhesive head of one or other of the prehensile threads and adheres to it firmly. While the prey-loaded filament rapidly shortens, the zoëa, which makes very strenuous movements, soon sticks to several prehensile filaments, which shorten as soon as they are touched. The zoëa is quickly so surrounded that it can no longer move. In this state it gets again within reach of the tentacles. The separation from the head of the prehensile filament is effected by the casting off of the adhesive granules. Whether a poisonous action is to be ascribed to the adhesive granules also

* 'Monograph of the Gymnoblæstic Hydroids,' vol. i. p. 28.

† Jenaische Zeitschrift &c. Bd. xv. p. 57.

cannot be determined. I have never observed a case in which a zoëa which had once been caught freed itself again.

Quite another picture is presented when a larger animal, such as an Annelid, accidentally touches a tentacle. Immediately all the prehensile filaments are withdrawn; but, on the other hand, the urticating batteries at the terminal ends of the large nematophores are projected far out; the tentacles also are concealed; so that a comparison with the formation of a square to resist an attack of cavalry is certainly appropriate.

I have indicated above that Allman's statement that the urticating capsules were not pushed forth with the other parts of the armed animal relates to a particular condition. I believe that he must have observed composite guard-animals in which the urticating capsules cannot indeed be protruded with the prehensile filaments, but certainly by themselves.

As a matter of course, I am far from assuming any genetic connexion between those Ctenophora which possess prehensile filaments and the Plumularidæ; but nevertheless I believe that, by the discovery of adhesive granules in Hydroids, some light is thrown upon the corresponding and hitherto isolated structures among the Ctenophora. As we see in the Plumularidæ that in the development of the composite guard-polyps urticating capsules *first* appear, and these are then *gradually* replaced by adhesive granules, we may well assume that the adhesive granules represent phylogenetically the younger structures. The same causes must produce the same effects; and thus, in the Plumularidæ as in the Ctenophora, selection may very well have converted the urticating capsules in part into adhesive granules: we have before us *analogous* structures.

Chun* and, subsequently, Claus† have asserted the homology of urticating capsules and adhesive granules; and I believe that, by the observations above described, this interpretation will be completely established as correct.

If we inquire, further, to what tissue the cells in which the adhesive granules originate are to be ascribed, their great resemblance to dermal glands, such as we know in various Coelenterata, must immediately strike one. In fact I do not hesitate to refer them to the unicellular skin-glands, and regard the adhesive granule, *which, like the urticating capsules, only acts once and then disappears*, as their secretion.

* Zoolog. Anzeiger, Bd. i. p. 50.

† 'Grundzüge der Zoologie,' p. 297, note.

II. On Urticating Cells in the Gelatinous Mass of the Disk of *Crambessa mosaica*.

During the histological investigation of this magnificent Rhizostomatous Medusa, which sometimes occurs in enormous swarms, I came upon some peculiar structures which occur in the gelatinous mass of the disk.

This gelatinous mass is pretty tough, and, in its firm structure, resembles the jelly of *Cyanea Annaskala**, which has been fully described by me. Only here, in accordance with the firmer consistency, the fibrillæ lie much closer together than in *Cyanea*. The increase in number affects chiefly the smooth fibrillæ. Granular fibres occur particularly well developed beneath the olfactory pit. Here they run chiefly vertically, and therefore pass through the disk-jelly transversely. Notwithstanding the probability raised by their position that we have here to do with nerve-fibres which unite the sense-epithelia of the oral and aboral surfaces of the disk, I am not inclined to regard them with any certainty as nerves, as, in spite of all my endeavours, I have not succeeded in detecting any direct connexion with them of the nerve-fibres which spread under the sense-epithelia.

Some of the granular fibres of the jelly beneath the olfactory pit become thickened at certain points, and contain large, long, and narrow urticating capsules, slightly curved into a sabre-like form. In the enlargement of the granular fibre, in which the urticating capsule lies, a nucleus may always be detected; and consequently the whole is probably to be interpreted as a cnidoblast. I found some of the capsules discharged; and in these cases the nettling thread was repeatedly bent and imbedded in the granular plasma which surrounds the capsule.

The consistency of the jelly is such that sections may be made through it without first hardening it. I was thus enabled to observe these urticating capsules in the living state. By the addition of acetic acid they may be at once caused to discharge, but the thread remains always in the plasma and never issues into the jelly. This seems to indicate that between the jelly and the cnidoblast there is a firm separating layer, which, however, is not optically perceptible. As with the tentacles of *Cyanea Annaskala* (l. c.), I have tried here also whether the urticating capsules discharge themselves when no direct irritation affects them, in order to ascertain whether a nervous action has anything to do with the discharge

* Zeitschr. f. wiss. Zool. Bd. xxxviii. p. 472.

of the capsules. In the present case this test succeeds very easily. When a transverse section through the margin of the umbrella under the olfactory pit is brought under the covering-glass in such a manner that the olfactory pit shows freely, and then its sense-epithelium is touched with acetic acid, the urticating capsules go off one after the other, those first which lie nearest to the irritated spot.

If it is thus rendered probable that the granular threads with which the cnidoblasts are certainly, and the irritated sense-epithelium perhaps, in continuity, this mode of discharge of the urticating capsules leads us to consider how the capsule is burst. We have here no mechanically acting cnidocil; and therefore cannot regard a pressure exerted from the sides upon the cnidoblast as the cause of the rupture. It seems to me rather to follow necessarily from the state of matters described that the irritation is transferred through the fibre to the plasma of the cnidoblast, and causes this to contract; for it is probably a fundamental property of still undifferentiated plasma to contract upon irritation. The plasma of the cnidoblast, however, has the form of a closed tube; and the uniform contraction of such a tube will have as its consequence a preponderance of the pressure on the sides of the elongated capsule, by which the nettling thread will then be pressed forth.

These urticating capsules occur exclusively in that part of the disk which, as the so-called covering lamina, closes from above the cavity in which the marginal corpuscle lies. At any rate they serve as defensive weapons for the protection of the marginal corpuscles, and are consequently analogous to that urticating pad which runs above the nervous ring of the *Craspedota*.

III. On Urticating Cells.

The valuable investigations of Hamann* have essentially advanced our knowledge of these peculiar microscopic weapons. Wright†, the discoverer of the palpcils of *Syncoryne*, without further consideration ascribed to the cnidocils the function of tactile setæ; but Schultze‡ raised doubts as to this interpretation, and Hamann now seeks to prove that in the urticating cells we have not to do with sense-cells. I believe that all zoologists will probably adopt this opinion. Hamann endeavours to prove that the centripetal process

* Jenaische Zeitschrift, Bd. xv., "Ueber Nesselkapselzellen."

† Proc. Roy. Phys. Soc. Edinb. vol. i. p. 341.

‡ *Cordylophora*, p. 22.

which Schultze (*l. c.*) discovered and all later observers have also found on the cnidoblasts is nothing but a pedicle which stands in direct connexion with the supporting lamella and represents a product of metamorphosis of a part of the plasma of that cell which also produced the urticating capsule in its interior. He states that this pedicle possesses the same optical and chemical properties as the supporting lamella. From his careful observations, extended over all groups of the Coelenterata, he draws the conclusion that in *all* Cnidaria the process has only a supporting function. To this induction, as such, of course no certainty can be ascribed, and it is in fact not correct.

In isolation-preparations of *Cyanea Annaskala** I have often seen cnidoblasts the centripetal processes of which were in connexion with ganglion-cells of the subepithelial layer. Leaving this out of consideration, these processes are not hyaline, but granular, and not different from that part of the plasma which surrounds the urticating capsule and lies in the neighbourhood of the nucleus. Besides these urticating capsules, I have also described smaller ones in which I could detect no processes, and the discharge of which does not depend, like that of the large ones, upon the will of the animal. I regard it as probable that these in reality possess such pedicles as Hamann describes, but which escaped me owing to their fineness. Thus I have found (*l. c.*) that the surface of the jelly beneath the urticating warts shows asperities. These asperities resemble sharp-angled sea-waves; and it is quite possible that fine threads issue from the projecting points and bear the small urticating capsules at their distal ends.

With regard to the pedicles of the urticating capsules of a *Syncoryne* which I have carefully investigated, and which is characterized by its quadriradiate structure, I can completely confirm Hamann's statements. The pedicle is perfectly hyaline and enlarged in a cup-like form at the distal extremity.

It is otherwise with the urticating capsules of *Medusæ* and *Actiniæ*; their processes are granular, and, as regards their substance, essentially different from the jelly and the supporting lamella. They are always soft, generally curved, and exactly resemble plasma-cords. It can easily be shown that, just as in the tentacles of *Cyanea*, so also in the *Actiniæ* the discharge of the urticating capsules is dependent on the will of the animal, so that we must assume that some mechanism

* Zeitschr. f. wiss. Zool. Bd. xxxvii. p. 480.

or other exists in these animals which is in connexion with the nervous system of the animal, and the action of which consists in its exerting, under certain conditions, a pressure upon the urticating capsule. Such a mechanism might exist either within the cnidoblast or outside it.

I believe that the former is the case, and support my opinion upon three facts.

In the first place we have before us in the cnidocil a structure which is evidently connected with the mechanism of discharge, just in the same way as the nervous system of the animal, because, under certain conditions, a touching of the cnidocil suffices to burst the capsules, just like an impulse of the will of the animal. But it is precisely the plasma-envelope of the urticating capsule in which both the cnidocil and the pedicle open, and thus at this place alone we shall probably have to seek the mechanism which can be set in motion from both sides.

It is indeed not impossible that the irritation of the cnidocil in fact comes as sensation to the knowledge of the subepithelial ganglion-cells, and that then only is some other mechanism for the discharge of the urticating capsules set in motion from this point. But this appears to me extremely improbable.

In the second place the urticating capsules in the disk of *Crambessa mosaica* discharge themselves upon nervous irritation; and it can scarcely be supposed that the irritations cause the contraction of the jelly in the vicinity of the cnidoblasts, but rather that they superinduce a discharging action in the plasma of the cnidoblasts itself.

Thirdly, we must here cite the noteworthy discovery of Chun *, who has detected in the plasma-envelope of the urticating capsules of *Physalia* a network of contractile fibres, by the contraction of which a rupture of the capsule can be easily effected. Here, in an animal celebrated for its urticating qualities, we find the plasma of the cnidoblasts of a higher grade; it has already secreted muscular fibres.

Considering these points, I would assume the contraction of the plasma-envelope to be the cause of the discharge of the urticating capsules, and not a contraction of the pedicle.

I have postponed the discussion of the centripetal extremities of the pedicles of the urticating capsules of the guard-animals described in § I. until now, because it may be of more general importance. Although I am not sure, the impression has been made upon me that the pedicles, as stated

* Zoologischer Anzeiger, Bd. iv. p. 646.

by Hamann, unite with the supporting lamella, and that therefore only a supporting function is to be ascribed to them, but that *finer threads from the multipolar ganglion-cells run up on these pedicles and place themselves in connexion with the plasma of the cnidoblast.*

If we compare the morphological characters of the urticating cells with the observation of living animals in the aquarium, we shall be struck especially by one peculiarity of the arenicolous Actiniæ; although hundreds of capsules discharge themselves when a digestible body touches the cnidocils, not a single one is discharged when sand falls upon them. If a freshly torn-off tentacle is placed under the microscope and there are many small animals in the water, we can easily observe how every contact of an animal with the surface of the tentacle is accompanied by a salvo of nettling threads, while not a single one can be coaxed forth if a rapid current is produced, and sand-grains, fragments of covering-glass, and the like are introduced under the cover.

In the Actiniæ therefore it seems to be dependent on the will of the animal whether the touching of the cnidocil shall or shall not be followed by a discharge. If this phenomenon be considered in connexion with the fact that urticating capsules are never discharged when the animal retracts its tentacles, when the pressure in the vicinity of the cnidoblasts is heightened by muscular contraction, and the cnidocils touch other bodies, I think I am justified in regarding the following process of discharge of the urticating capsules as the most probable:—*There exists a continuous connexion between the nervous system and the plasma-mantle of the urticating capsule. The urticating capsule is ruptured by the pressure which the plasma-mantle exerts upon it* *. In *Cyanea Annaskala* there is added to this a stellule which breaks through the membrane of the distal pole. In *Physalia* the plasma has already separated muscular fibres. The contraction of the plasma-mantle is induced by an excitation proceeding either from the cnidocil or from the nervous system. Further, however, a preventive excitement may issue from the nervous system, which paralyzes the cnidocil—excitation which, under ordinary circumstances, would burst the capsule. The nervous system can therefore take on the function of a "preventive centre," while the discharge by the cnidocil-excitement is to be compared to a "reflex movement." Here therefore we already see the commencement of that reciprocation of reflex and preventive action to which modern psychology ascribes such great importance.

* In this I find myself in agreement with Uhun (l. c.).

If we now consider the urticating cells we shall find that they may be compared both with the epithelial muscular cells and with the dermal gland-cells. Certainly in all cases, with the exception of *Physalia*, their glandular nature comes most prominently forward, for we have a plasma-derivative which is thrown off outwards, and consequently may be regarded as a secretion, while usually there is no contractile plasma-derivative; and we are not justified in speaking of muscles when we describe a structure which certainly contracts on irritation, but in which two kinds of substance are not recognizable, and in which therefore no profound division of labour has taken place in a contractile and a plasmatic part.

Independently of this, however, the double irritability of the cnidoblasts is in favour of the view that there may be "neuromuscular cells" which occur together with sense-organs and ganglion-cells, a view which has been opposed by Claus, the brothers Hertwig, and myself. But the cnidoblasts are such peculiar structures that we can scarcely draw any conclusion from them as to epithelial muscular cells, so that the neuromuscular theory can hardly be supported by them.

The glandular nature of the cnidoblasts becomes particularly probable if we accept the homology between adhesive granules and urticating capsules; and I would therefore regard *the cnidoblasts as unicellular dermal glands*.

XXXI.—*On a Case of Commensalism of a Caranx and a Crambessa.* By M. GODEFROY LUNEL*.

THE case which has furnished me with the subject of the present memoir relates to animals belonging to very different classes, namely Fishes and Medusæ. Numerous memoirs, the enumeration of which would be out of place here, have been published by the older and more recent naturalists upon the organization and anatomy, or upon the development or the zoological characters of the animals of the latter class. I shall therefore confine myself to referring, at least in part, to what has been said upon their mode of alimentation.

The Medusæ feed upon small naked pelagic animals, and even, according to some authors, upon small fishes, which they

* Translated by W. S. Dallas, F.L.S., from the 'Bibliothèque Universelle,' période 3, tome x., Archives des Sciences, p. 271, September 15, 1883.

seize and draw towards the mouth by means of their tentacles, their arms, and the urticating organs with which these are armed. This is what Spallanzani * supposed, he having seen a small fish adhering to one of the appendages of a Medusa which he had just captured. Müller †, Otho Fabricius ‡, Dicquemare §, and Bosc || state that they had seen Medusæ digest fishes. According to Péron and Lesueur ¶ the Medusæ make their regular prey of fishes from 12 to 15 centimetres long; and although their stomachs appear incapable of having any kind of action upon those animals, the latter were digested in a few moments. Gaede ** asserts that he found small fishes in the stomachs of Medusæ that he dissected. Eysenhardt and Chamisso †† have also stated that they several times met with the heads and remains of fishes, which had apparently been digested, in the stomachs of Medusæ. Professor de Blainville ‡‡ says that he had himself sometimes found small fishes in *Æquorea* and even in Rhizostomes; but he questions whether these small fishes had really been captured by the Acalephs, or whether they did not occur by accident where they were found. Cuvier was of the latter opinion, at any rate with regard to the Rhizostomes, having ascertained that those animals draw up their nourishment by a kind of suckers. Quoy and Gaimard §§, referring to the authors above cited, who declared that they had seen Medusæ digest fishes, think themselves able to assert that so complicated a phenomenon of digestion is perfectly impossible in the case of some species which are destitute of suitable organs for effecting it. In support of their assestion, and as furnishing an indisputable proof of it, these naturalists cite the capture made by them of a new species of *Dianœa* in the Mediterranean, near the coast of Valencia and the Balearic Islands. This Medusa, the structure of which did not differ at all from that of the other Radiaria of the same genus, presented no aperture which could enable it to allow the entrance of any substance of appreciable bulk. As to the figure given by Müller, and reproduced by other authors, of a Medusa swallowing a fish, Quoy and Gaimard say that it proves nothing, for, as Cuvier had pointed out, this fish could very easily have

* Opuscoli di fisica animale e vegetabile, 1776.

† Zoologia Danica, 1776-80.

‡ Fauna Groenlandica, 1780.

§ Phil. Trans. and 'London Physical Journal.'

|| Histoire naturelle des Vers, 1802-15.

¶ Annales du Muséum, 1809, tome xiv. p. 325.

** Beitrage zur Anatomie und Physiologie der Medusen, 1816.

†† Acta Acad. Leopold. Nat. Cur. 1821, vol. x. part 2.

‡‡ Dict. des Sci. Nat. 1823, tome xxix. pp. 389 *et seqq.*

§§ Voyage de l'Uranie, 1824, Zoologie, pp. 559 *et seqq.*

introduced itself through an aperture which is almost always gaping, and which offers but little resistance.

According to Lesson* the prey of the Medusæ consists of small fishes &c., which they stupefy by a liquid which is caustic as regards this prey, but which often has no action upon man, although certain species are truly urticant when touched. The same author says that he had often seen the flesh of tolerably robust fishes absorbed by the parts of the Medusa which pressed against the scales, displacing them, and by their contact decomposing the fleshy matter into a sort of rosy sirupous liquid. Lastly this author adds that the wide inferior apertures to which Péron gave the name of *cavités stomacales*, while Lamarck, Cuvier, and De Blainville called them mouths, serve the Medusæ to swallow their prey.

In 1848, being on the beach of Maguelonne, near Montpellier, at the moment when the fishermen had brought in their net with several large Rhizostomes, I observed in the interior of one of these Medusæ a fish nearly as long as my finger, which still showed some signs of life and was in a perfect state of preservation. I could not, however, recognize the species, nor can I say in what cavity of the Medusa the fish was lodged. I may add that the fishermen greatly dread the corrosive action of the Medusæ upon their nets.

The Medusæ are not edible, and only serve as food to the Actiniæ, which seize them in passing by means of their tentacles. Whales are said to consume the small species in great quantities, engulfing them in their enormous mouths with other animals of different types which abound in the seas frequented by these great Cetaceans.

Fishes have sometimes been observed swimming around Medusæ and apparently pursuing them, which has led to the belief that these Vertebrata followed the Medusæ in order to feed upon them. Professor Cocco† was the first to make known a Mediterranean fish which, towards the end of the year 1834, appeared wheeling round a quantity of Medusæ, which in that year swarmed in the neighbourhood of Messina. The fact was inquired into soon afterwards by the same professor, who, from further observations, thought himself justified in giving this fish the specific name of *medusophagus*, or *eater of Medusæ*, on account of the avidity which it showed, according to him, in feeding upon the filiform tentacles of these Sea-Nettles, and the generic name of *Schedophilus*, which signifies *lover of the shade*. He adds that some Sicilian

* Hist. Nat. des Zoophytes Acalèphes, 1848, p. 162.

† Giorn. Innom. Mess. ann. iii. no. 7, p. 59.

fishermen called it *Pisci d'Umbra*, while others named it *Pisci Purcu*, or pigfish.

Dr. Albert Günther* has described and given a coloured figure of a *Schedophilus medusophagus* preserved in spirit, which he received, in May 1882, from his friend Mr. G. Douglas Ogilby with the following notes :—

"The fish was obtained during the second week of August 1878, in a salmon-net, at Portrush, co. Antrim, and came at once into my hands, none of the fishermen engaged in the fishery having previously met with any thing similar to it. It was the most delicate adult fish I ever handled—so much so that, within twenty-four hours of its capture, the skin of the belly with the intestines fell off when it was lifted, and it felt in the hand quite soft and boneless. Its stomach contained herring-fry. I may mention that a few days subsequently to the above date I got a fine specimen of a Tunny, also at Portrush." Dr. Günther says that the fish obtained by Mr. Ogilby was a fine example of *Schedophilus medusophagus*, a genus which had not previously been met with near the British coast. He adds, "Originally described from specimens obtained in the Mediterranean, the species was afterwards found in the open Atlantic †, and quite recently in the South Sea ‡ near Samoa. It is evidently a pelagic form which, at least in the adult state, descends to some depth. The want of firmness in the tissues, well described by Mr. Ogilby, seems clearly to indicate it as a deep-sea fish. But we have no evidence as to the exact depth to which it may descend, which probably does not exceed a hundred fathoms.

"As in other deep-sea fishes, the young of this species are more frequently found near the surface than the adult, which are very rare. They accompany floating objects, chiefly for real or fancied protection, or for the sake of animalcules which congregate round every object floating on the surface of the sea; this is what induces these little fish to follow *Medusæ*. The idea expressed by the specific name of our fish, viz. that it follows *Medusæ* in order to feed on them, cannot be correct, as the fish could draw but little nourishment from those animals." Lastly, according to Dr. Albert Günther, "The specimen obtained by Mr. Ogilby probably followed one of the shoals of fry of Clupeoids which annually travel from the open sea towards our coasts, and are followed by a number of southern fish which prey upon them and in their

* Trans. Zool. Soc. Lond. vol. xi. p. 223, pl. xlvii.

† Günther, Catal. of Fish. ii. p. 412; Lutken, Vid. Selsk. Skr. 1880, p. 525.

‡ Günther, Fische d. Sudsee, p. 149.

turn are pursued by larger pelagic fishes, such as Tunnies and other Scombroïds."

Prof. H. Fol has given to the Museum of Geneva two individuals, one of them very young, of *Schedophilus medusophagus*, which he collected in the Bay of Messina at the time when he was devoting himself to the study of the lower animals of the Mediterranean. This naturalist has also seen these fishes swimming about Medusæ; but he has never observed that this was for the purpose of feeding upon them, nor did he see the Medusæ prey upon the fishes. Dr. Fol therefore does not believe that the Medusæ could eat fishes, however small: these Acalephæ, whose organization is so simple and so feeble, do not possess digestive organs powerful enough to digest a prey so firm. The Actiniæ even, in which the tissues and the organs of digestion are better formed and developed than in the Medusaria, often only partially digest the small fishes and other little animals which they may capture, and reject the parts which are somewhat hard.

The following observations may furnish, at the same time, some interesting data as to the habits of certain species of fishes, and an explanation, perhaps more conclusive than that which has hitherto been given, of their manœuvres with respect to the Medusæ.

In a consignment of objects from the Mauritius sent to the Museum of Geneva by M. de Robillard, in May 1882, there were united and preserved in spirit a *Caranx melampygius*, C. & V.*, and a *Crambessa palmipes*, Häck.†. The former of these animals was fixed by the greater part of its body in the apertures formed by the four columns which unite the stomach to the umbrella in the latter, and are traversed by canals serving to establish a communication between the stomachal cavity and the rest of the gastrovascular system‡.

All the hypotheses which tend to explain the association of fishes and Medusæ by assuming that one of these animals seeks the other as prey and for food are evidently inadmissible in the case now before us; for the Medusa belongs to the family Rhizostomeæ, and consequently has no buccal aperture properly so called, but only a series of microscopic pores which enable it to absorb food only in a state of extreme

* Hist. Nat. des Poissons, 1833, tome ix. p. 116.

† System der Medusen, 1880, Bd. i. 2nd part, p. 620.

‡ I am indebted to the kindness of Dr. H. Fol for the determination of this Medusa, at least so far as he could make it with certainty, for the very indifferent state of preservation of the specimen did not enable him to count the lobules of the margin of the umbrella, which are no longer visible. I may add that Hackel described *Crambessa palmipes* from specimens coming from the northern coast of Australia.

division; and, on the other hand, the fish only lodges itself in a natural cavity of the Medusa—a cavity which has nothing to do with the digestive or gastrovascular system. This cavity is widened by the prolonged use which the fish has made of it, and nevertheless the *Crambessa* is perfectly uninjured—an evident proof that the fish regards its associate as a place of refuge and not as a prey.

Surprised at the singularity of this fact, I wrote to M. de Robillard to ask him for some details upon the subject. The following is the reply that I received from him:—"The facts to which I called your attention with regard to the little fish which follows the anemone and constantly enters into it without quitting it is perfectly correct; the fisherman who brought them to me captured them together. I can personally certify the fact. It is some years since, being on the quay of our port, I observed the same thing; it was also the same species of fish as that which I sent to you which entered into the anemone and issued from it; and as this took place at about 6 inches under water, it was very easy to observe what went on. The fish was alone, there were no others. What explanation is to be given of this phenomenon? Is it that the fish finds something to eat in the anemone which induces it to pursue and penetrate into it? I cannot say: the anemone, although receiving the fish, is alive, and one sees it move. You should verify the interior of the anemone to see that nothing has been destroyed by the fish."

Lastly, having requested M. de Robillard to endeavour to procure for me, if possible, some specimens of the two animals in question, I received from him, while I was engaged in preparing these notes, a letter, dated July 15, 1883, announcing a fresh consignment of objects for the Museum, and further a tin box containing two Medusæ, each with its little fish; he had received them in sea-water, the fishes and Medusæ all living. I do not know how it came about that, unfortunately, all the objects announced were in the case except the box with the Medusæ; I suppose that M. de Robillard forgot to put them in.

Leaving on one side, then, all the hypotheses hitherto put forward about Medusæ eating small fishes and small fishes eating Medusæ, I arrive at the following conclusion, corroborated by the fact which I have pointed out, namely, that there are certain species of fish of which the adults live at more or less considerable depths, and of which the young, compelled either by some undetermined peculiarity of their organization or by the necessity of seeking food better suited to their age, come up to seek certain Medusæ at the surface of the sea. It

is there that the small pelagic animals upon which they feed swarm, as also do the Medusæ. Then comes to pass this very strange fact, which, however, is none the less proved, namely, that the fish, entering into certain natural anfractuositities of the Medusa, lodges there, issues thence, returns there at pleasure, and thus becomes its commensal. This is the only way, I believe, to explain this kind of association between two animals of such different types. It is to be remarked that, in order to penetrate into the Medusa without lacerating its tissues, the fish is compelled to swim on one side, that is to say in a perfectly abnormal position.

I take advantage of this opportunity to make known a new case of parasitism. I refer to the discovery of two examples of *Dorychthys eacisus* (Kaup), male and female, found living in a Holothuria. These two fishes were sent to me from the Mauritius in October 1881 by M. de Robillard, with the assurance that they were quite alive when he took them out of the Holothuria. Unfortunately he could not tell me the species to which the Echinoderm belonged. Under any circumstances the fact seemed to me the more interesting and the more deserving of being noted, as it is, I believe, the only case of parasitism hitherto observed in the case of a fish of the order Lophobranchii.

The following are some characters of this *Dorychthys* which may serve to identify the species or to determine the age:—Total length 50 millim. Plates 18+15—16.

BIBLIOGRAPHICAL NOTICES.

Minute Structure of the Central Nervous System of certain Reptiles and Batrachians of America. Illustrated by permanent photomicrographs by JOHN J. MASON, M.D. Series A. Author's Edition. One hundred. Newport, 1879-1882.

THE methods of histology have reached a perfection which is building up new departments of knowledge; and among successful pioneers in these labours Dr. Mason will always hold an honoured place for the technical skill with which he brings the reader face to face with the revelations of his microscope, and for the sumptuousness with which his work is given to the world. No such monograph has previously come under our notice, for the illustrations of a difficult research leave nothing to be desired. Some nineteen reptiles and batrachians have been studied; and the author has turned his attention to the structure of the spinal cord, the medulla

oblongata, cerebellum, optic lobes, and cerebral and olfactory lobes of the brain, making important discoveries in every direction. The subject is treated in a comparative manner, so that each region is studied through a number of animals and under different powers of the microscope, the results being represented in 113 quarto plates, which have been selected, as the author states, from over 5000 preparations, and form a comparative anatomy of the nervous system. The text, exclusive of the literature and explanation of the plates, only extends to twenty-four pages; but this brevity is due to the setting down of nothing but results. The author first describes his method of hardening, and details some examples of the variation in hardening and staining which the species exhibit. The tailed Batrachians stain easily, but require a third more time to harden than specimens of other orders. The sections were stained after being cut, transparency produced by oil of cloves, and the slices were mounted under thin glass in Canada balsam dissolved in chloroform. These sections are photographed on glass and developed with sulphate of iron, the glass having previously been coated with a solution of wax and benzole. The collodion-film is made adherent to a thin sheet of gelatine and removed from the plate, when it becomes available for the artotype process of printing, by which the beautiful results here presented were obtained.

The spinal cord is exemplified in no fewer than forty-four plates, and elucidated in seven pages of text. As among higher animals, this organ consists of white and grey matter, and the white matter shows the usual division into six columns; but the cord is characterized by an absence of the superior or posterior fissure, so that the union of the posterior columns is closer than in man. Two longitudinal bundles of white nerve-fibres extend along the spinal cord in Saurians, between the inferior white and grey commissures, extending forward from the lumbar region to form the central longitudinal bundle of the medulla oblongata on each side. These columns are especially conspicuous in the alligator, iguana, heloderma, skink, and anolis. The author finds that reptiles which are shielded by bony plates or by thick scales have the fibres of the superior columns of the spinal cord relatively smaller than in naked reptiles. The infero-lateral columns of the spinal cord are larger in the cervical than in the lumbar region. Some of the plates show well the "lateral ligament" of Dr. Mason. Other plates show the nerve-cells and the root-filaments of the nerves, together with their modes of exit. The contour of the grey substance in section is not unlike its contour in man, though in Ophidians the superior horns blend, and among Batrachians a reticular substance becomes interposed between the two halves of the grey matter. This substantia reticularis is equally large in the brachial and crural regions, and in the latter surrounds the central canal. This canal is lined with conical ciliated epithelium, and the processes given out from the cells in the frog's spinal cord are shown to be continuous with the network of the substantia reticularis. This substance is admirably exhibited in the plates, and, according to the author, affords "probably the best

example of what is almost universally regarded as connective tissue." Concerning the relative development of white and grey matter, it is seen that there is more white matter in the brachial region and more grey matter in the crural region of the frog. And since the length of the lumbar enlargement is to the cervical enlargement as 10 to 6 in the frog, it is evident that the grey matter is much more abundant in the lumbar region. Long-tailed Saurians like iguana and the alligator have the white and grey substances nearly equal at both enlargements; but those with short tails have the cervical enlargement more developed. Chelonians usually have no large nerve-cells in the inferior horns of the grey matter. In the gopher, multipolar and bipolar cells occur, which are similar to those seen in enlargements of the spinal cord in reptiles. Nerve-cells with nuclei, though abundant, only form a distinctly defined group in the dorsal region of the frog, above the level of the central canal, on each side of the substantia reticularis. In the frog the axis-cylinders of the inferior nerve-roots can be followed into the grey matter, and become lost in the large cells. These are the more important conclusions which the author formulates; but the materials which are represented in the plates make it manifest that a reticence and modesty have been shown, which throw a good deal of labour upon the reader in efforts to generalize where the author would probably have been more successful.

The spinal cord passes very gradually into the medulla oblongata, where the central canal and inferior commissure in Saurians occupy a lower plane, though in the alligator it rises and opens into the ventricle. Here the raphe appears, and extends as far forward as the substance which corresponds to the pons Varolii. In the meshes of the raphe are nerve-cells which extend forward, till just behind the plane of the auditory nerves they become the largest cells of the nervous system. Similar cells occur in skinks, anolis, heloderma, iguana, and all Saurians which have the raphe well developed. On each side of the raphe cells are arranged in three groups, which have been called nucleus basilaris, nucleus centralis, and nucleus lateralis. The nucleus centralis includes superior and inferior divisions. The author observes that this centre in the crocodile may be related to the vagus; but adds that it is perhaps more probable that the cell-column which extends from the anterior bundles of the spinal accessory to the anterior bundles of the vagus contains all the cells in which both the vagus and hypoglossal nerves originate, the reason for this doubt being that the roots of the hypoglossal nerve have not been traced. The origin, however, of the abducent nerve is evident in all the reptiles examined; it lies in the floor of the ventricle, and is well seen in section.

The cells connected with the auditory nerves show many variations in the different animals. In the frog the motor bundle of the trigeminal nerve is seen in cross sections, though it is more easily demonstrated in true reptiles, and is well shown in a section of the medulla oblongata of the alligator.

The cerebellum is represented by longitudinal vertical sections.

In the marine turtles it completely covers the fourth ventricle, extending back twice as far as in the alligator. In the frog it is vertical, while in the tailed Batrachians it is more or less blended with the optic lobes. In *heloderma* the cerebellum curves forward, but is not closely applied to the optic lobes, as in other lizards. Just in front of the cerebellum is the *valvula cerebelli*, which contains the decussating fibres of the fourth pair of nerves.

The optic lobes are admirably represented in fifteen plates, which display the microscopic anatomy of this region of the brain in a striking manner, demonstrating a greater diversity of structure than would have been anticipated. This region of the brain in Ophidians appears to be characterized by an absence of the linear arrangement of the cells of the cortical layer, such as is seen in other reptiles and in Batrachians. In Chelonians there is a remarkable ganglion formed of large cells in the roof of the optic lobe over the ventricle, and on each side of the central group are other layers of small cells. These layers of cells are regarded as the origin of the optic nerves. Beneath the optic lobes, in the peduncle, are the cells and fibres in which the oculo-motor nerve rises, though in the tailed Batrachians the origin of this nerve is not seen. In the axolotl some doubt appears to attach to the distinctness of the optic lobes. The optic thalami are seen one on each side of the V-shaped third ventricle, in front of the optic lobes. Beneath are the tuber cinereum and the cerebral hypophysis.

The cerebral hemispheres are examined in somewhat less detail; but the plates show a general correspondence of the parts in the several types. The corpus striatum is much larger in Lizards and Ophidians than in Batrachians; and in the alligator this organ is relatively larger than in the *heloderma*. In the box-turtle the corpus striatum has about the same development as in lizards.

Having thus treated in general terms of the chief parts of the central nervous system, the author prints an appendix on the average size of nuclei in the nerve-cells which are related to motor nerves, showing that the nuclei of the motor cells of the central nervous system have in the same individual a size which is proportional to the power in the related muscles. Similar relation of size in the nerve-cells is found in the spinal column to govern muscular development in the limbs; and the later plates are devoted to demonstrating the size of the nuclei in the cells connected with cranial nerves.

In a second series the author promises to examine the minute anatomy of the basal parts of the brain. The list of plates gives their amplification and subject; while on the plates themselves, besides description and number of the negative, the power of the object-glass and its maker are mentioned.

No words could do justice to the beauty of the plates or the value of the information they convey; and it is not too much to regard this work as opening a new era in research by substituting knowledge of facts of microscopical structure for their interpretation by the hand of artist or author; but we can scarcely hope to see many

books so beautifully illustrated. The author's method has the merit of inaugurating a comparison of the minute anatomy of the nervous system by enabling the reader to see the structures which he has discovered as he saw them; and hence the book will always be a valuable work of reference; and it will certainly induce others to hand on the torch of knowledge in a like excellent way.

Memoirs of the Geological Survey of India. Palæontologia Indica, being Figures and Descriptions of the Organic Remains procured during the progress of the Geological Survey of India. Published by order of his Excellency the Governor-General of India in Council. Series x. *Indian Tertiary and post-Tertiary Vertebrata*. Vol. II. Part 1. *Siwalik Rhinocerotidæ*. Part 2. *Supplement to Siwalik and Narbada Proboscidea*, with 11 plates: 1881. Part 3. *Siwalik and Narbada Equidæ*, with 5 plates: 1882. Part 4. *Siwalik Camelopardalidæ*, with 7 plates: 1883. Part 5. *Siwalik Selenodont Suina &c.*, with 3 plates: 1883. By R. LYDEKKER, B.A., F.Z.S., Geological Survey of India. Calcutta: the Geological Survey Office. London: Trübner & Co.

THE five parts published of the second volume of the Indian Tertiary Vertebrata are all by Mr. Lydekker, and devoted to Siwalik fossils. The volume will apparently include other parts, but already extends to 176 pages and 25 plates. There is no reason for the association of the parts in the way in which they are issued, and every part has a separate pagination as well as the pagination of the volume; the plates take the numbering for the volume only. On account of the wealth of material and interest of the types described, this work will always be important in palæontology; and we cannot help believing that its value is enhanced by the manner of dealing with the systematic part of the subject which the author has adopted, for the aims of science are certainly better served by making genera large and then showing the characters wherein the species differ from each other, than by adopting the too common method of subdividing genera till the evidences of their mutual dependence and of the evolution of species are obscured. If any one should observe that the author has not always adhered to so excellent a plan, it must be conceded that when the materials are scanty and the types such that their true nature cannot be worked out, then it becomes permissible to formulate whatever knowledge is available by a nomenclature which shall not prejudice affinities.

It is almost impossible to separate the fossil forms of rhinoceros from those which still live. Dr. Falconer detected the hornless rhinoceros, which he named *Acerotherium perimense*, and to this species Mr. Lydekker now refers the *Rhinoceros pluvians* and *R. irawadicus*, which he has defined in the former volume: the teeth approach those of the rhinoceroses of Sumatra and Java. This is the only occurrence of *Acerotherium* in the Siwalik beds. The other

fifteen fossil species, according to Mr. Lydekker's table, all occur in the Miocene rocks of Europe and North America. Some contribution is made to the knowledge of *Acerotherium* in the description of a cranium, of which the author gives a restoration. As compared with the *Acerotherium incisivum*, the Indian species has the nasal bones thicker at the base and apparently shorter; there is a greater depth from the dental border of the orbit to the teeth; the temporal fossæ in the Indian form are wider and shorter, and other differences help to distinguish the species. The dentition is described in detail, from which it appears that there are four premolar teeth and three true molars, while in front of the premolars there is the root of an incisor. These teeth are characterized by a well-marked cingulum, which distinguishes this animal from the associated species of rhinoceros, though the cingulum is well developed in the *Rhinoceros deccanensis* of Foote.

Having compared the dentition with such types as were likely to throw light upon the species, the author passes on to the genus *Rhinoceros*, recognizing thirty species living and fossil, of which the four Siwalik species defined by Dr. Falconer still remain the only Indian types from this horizon. The author commences with some notice of the *Rhinoceros sivalensis*, affirming that the species is not hexaprotodont, describes some molar teeth, and points out resemblances between the molars of this species and those of *Rhinoceros javanicus*, and observes that the only character by which he can distinguish the molars of the living and fossil form is a difference in the relative dimensions of the teeth—the greatest width of the anterior surface being exactly equal to the greatest length of the external surface in the molars of *R. sivalensis*, whereas in *R. javanicus* the anterior measurement is greater than the external measurement; so that, were it not for the difference in form of the skull, the author doubts whether a specific difference could be established on the character of the teeth. This tooth-character is of some interest, since *Acerotherium* and all the Miocene species of *Rhinoceros* possess teeth of the type represented at the present day by the rhinoceros of Sumatra, which approximates towards the teeth of *Palæotherium*, *Anchitherium*, *Hyachyus*, and other old Perissodactyles; and on this circumstance Mr. Lydekker relies in explaining the resemblance between the milk-molars of the Sumatran and Indian types, because ancestral characters are often retained in the deciduous teeth long after they are lost in the permanent teeth. Hence he refers all species which approximate to the *Rhinoceros indicus* to a comparatively recent origin, the oldest form, *Rhinoceros platyrhinus*, only occurring in such parts of the Siwalik beds as are of Pliocene age. An excellent critical discussion of the mandible results in the conclusion that the form hitherto referred to *Rhinoceros palæindicus* must be assigned to the *Rhinoceros sivalensis*, partly because there is no known unicorn species without lower incisors, and partly because the platyrhine type of jaw is found in the beds which yield the molars of *Rhinoceros sivalensis*, but also because in form the jaw and teeth so closely resemble "the corre-

sponding parts of *R. javanicus* that it would be but a waste of words to give a detailed description." A variety of *Rhinoceros sivalensis* which occurs in the Gaj beds of Miocene age, in Western Sind, is described by Lydekker under the name of *gajensis*. It is known from the hinder half of the skull, in which the supraoccipital angular ridge is of moderate height and the molar teeth are seen.

R. sivalensis is apparently a unicorn species with a cranium intermediate between *R. indicus* and *R. javanicus*; and though its molars are like the teeth in the latter species, it is distinguished by wanting the median lower incisors. The fossil form is regarded as the ancestor of its living ally. The second species, *R. palaeindicus*, appears never to have been described by Falconer, and the author now gives some account of the skull, molars, and mandible. It is found throughout the sub-Himalayan Siwaliks, from the Ganges to the Indus, but is rare in the Punjab. The true molars are distinguished from those of *R. sivalensis* by the greater flatness of the external surface of each tooth, due to the absence of a buttress at the antero-external angle. A small skull in the British Museum presents some variation in the premolars, but the author refers it to *R. palaeindicus* on account of the form of the head.

The third species of *Rhinoceros* (*R. platyrhinus*) also was left undescribed by Falconer. It is a two-horned species with very wide and thick nasals, and with the supraoccipital region produced into a high crest; and presents no affinities with the *R. sumatrensis* or with the Miocene *R. Schleiermacheri*. Among the European fossil species the nearest correspondence is seen in the *R. tichorhinus*; but the European species is distinguished by having a nasal septum.

Finally, in his remarks on the pedigree of the Indian species of rhinoceros the author observes that *R. javanicus* is probably the descendant of *R. sivalensis*, that the rhinoceros from the Pleistocene deposits of the Narbada valley is practically identical with the *R. indicus*, and that no species in the Siwalik Pliocene beds can be regarded as the direct ancestor of *R. indicus*, the fossil form *R. palaeindicus* being exactly intermediate between the Sumatran or *Acerotherium* type and *R. indicus* in its molars. The *Rhinoceros sumatrensis*, which is well known to closely resemble the *R. Schleiermacheri*, is supposed to have descended with it from a progenitor which is still unknown. The group to which the *R. platyrhinus* belongs is still uncertain, for it had not the aborted premaxilla of the Pikermi and African species, from which it is also distinguished by the union of the inferior squamosal processes; yet in the form of its upper molars it closely agrees with *R. sinus*. The Pleistocene *R. diccanensis* is inferred to be a bicorn species from its mandible. The paper concludes with a list of the more important memoirs on *Acerotherium* and *Rhinoceros*, and is illustrated with ten plates, which are almost entirely representations of teeth.

The supplement to Siwalik and Narbada Proboscidea gives a brief account of fragments of maxilla and mandible of the *Dinotherium indicum* from Perim Island; and the *Mastodon pandionis* is better

known by the occurrence of three mandibles from Perim Island and the Punjab. The author further quotes from Dr. Naumann the occurrence in Japan of the Indian proboscideans *Stegodon Olfiti* and *Stegodon insignis* or *bombifrons*, and the *Elephas namadicus* and apparently *Elephas primigenius*. The two *Stegodons* were previously known to range into China; and the occurrence of these forms in Japan would indicate that the Siwalik and Narbada elephants ranged northward into a region which now belongs to the palæ-arctic province.

The Indian fossil horses comprise two species of *Hippotherium* and two of *Equus*, all of which are known chiefly from the teeth, though a few bones of the extremities and a more or less complete skull or two have been found. In the early stage of wear the upper molar teeth of *Hippotherium* are distinguished by complete isolation of the anterior pillar, though in well-worn teeth this pillar becomes united to the crescent, as in *Equus*. The *Hippotherium antilopinum* named by Falconer may possibly, as Owen suggested and Von Moyer urged, be identical with the *H. gracile* of Europe—a resemblance which was recognized by Prof. Gaudry, though he was afterwards led to think this species monodactyle. The American species of *Hippotherium* have a simpler structure of the enamel folds. The second species of this genus is the *Hippotherium Theobaldi* of Lydekker. It is distinguished from the foregoing by a much greater proportionate length of the milk-molars, and has the anterior pillar of the tooth compressed so as to be longitudinally elongated, and the posterior pillar extends back to the hinder border of the crown. The enamel is but slightly folded and the cement thin; yet the author observes that if the milk-molars had not been known, it would have been doubtful whether the true molars would have afforded ground for the formation of two species.

Among the limb-bones are some more or less complete feet; a fore limb which is figured shows the lateral digits about as well developed as in the stout variety of the Pikermi Hippothere figured by Professor Gaudry; and it is evident that the lateral metacarpal bones were not blended with the median metacarpal, at least at their distal end. The horses, as Mr. Lydekker observes, are not to be easily distinguished in a fossil state from asses. The Indian *Equus sivalensis* has the anterior pillar of the tooth smaller than in *Equus caballus*; but the remains indicate an animal at least 15 hands high. The *Equus hemionus*, or the Kiang of Thibet, has upper molars so like those of *sivalensis* that the author believes it would be impossible to distinguish them if both occurred in the same fossil state. There is a distinct trace of a 'larmial' cavity in the skull, which is developed in the hippotheres and unknown in living horses. The second horse is the *Equus namadicus* of Falconer, with which is now united the *Equus paleonius*. It is distinguished by the upper molars having a greater length of grinding-surface of the anterior pillars, and it is distinguished from all living horses by the square crowns of the upper milk-molars. In the living horse the plication of the enamel is always less than in the *E. namadicus*. It appears to be associ-

ated with the *Bubalus palœindicus* and *Camelus sivalensis* in the top beds of the Siwaliks. The memoir concludes with a bibliography of *Equus* and *Hippotherium*, and five plates representing teeth and a foot.

Mr. Lydekker regards the giraffes and sivatheres as forming one family, the Camelopardalidæ, which includes the genera *Camelopardalis*, *Orasius*, *Vishnutherium*, *Helladotherium*, *Hydaspietherium*, *Bramatherium*, and *Sivatherium*. The author believes that this group is most closely allied to the deer, though the views of Rüttimeyer are subsequently quoted as to the horns being intermediate between true antlers and true horns. Rüttimeyer follows Murie in uniting the Sivatheres with the antelopes because the parietal region is shortened, as in the oxen and the gnu; but the author observes that a skull now referred to *Helladotherium* was referred by Falconer and Murie to a female *Sivatherium*, and the transition from the *Sivatherium* to the giraffe seen in the bones of the limbs and neck and the presence of lachrymal vacuities in the giraffe and *Hydaspietherium* afford evidence of close relationship between these animals. The family is characterized by a reticular or rugose structure of the enamel of the molar teeth. Horns are unknown in *Helladotherium*; but the absence of a burr appears to prove that the large antlers of *Bramatherium* and *Sivatherium* were permanent. The fossil giraffes of Europe are of Miocene age; but the *Camelopardalis sivalensis* of the Siwaliks belongs to the Pliocene period. Teeth, vertebræ, and limb-bones are described, with the conclusion that the animal was about the size of the living species, the neck and limbs having attained their characteristic elongation in the Pliocene age.

Vishnutherium is a ruminant of giraffe type known from molar teeth, metatarsus, and cervical vertebræ. The jaw is slender, the molar teeth are larger than those of the giraffe, have a distinct cingulum on the outer surface, and a relatively large tubercle in the median valley of the first and second molars. The teeth are larger than those of the elk, but somewhat resemble them. The metatarsus is longer and slighter than the metatarsus of *Sivatherium*. The sixth cervical vertebra is shorter than the corresponding vertebra of the giraffe and longer than that of *Sivatherium*.

Helladotherium appears to be represented by the Pikermi species *H. Duvrnoyi*. It is known from the cranium, which was identified by Professor Gaudry. *Hydaspietherium* is a new genus, to which the author refers two species, *H. megalcephalum* and *H. grande*. The former is known from a nearly complete cranium wanting the horn-cores. It has a large subquadrate compound base for the horns immediately in front of the occipital crest, and has a large lachrymal cavity, which is wanting in *Sivatherium*. The teeth differ from those of *Sivatherium* in being smaller, in having a finer texture of outer surface, in the absence of plication of the enamel of the central pit, and the less development of costæ on the external surface of the lobes. The teeth are very similar to those of *Bramatherium*; and the author remarks that if there were no evidence but the teeth, *Hydaspietherium*, *Helladotherium*, and *Bramatherium* might all be

merged in one. Mandible, molars, limb-bones, and vertebræ are described in so far as is necessary to illustrate the differences of the genus from *Sivatherium*; and these structures show that in length of limb it was nearest to *Halladotherium*, in structure of horns nearest to *Sivatherium*, and that in length of neck it is nearer to *Vishnutherium* and the giraffe than to the *Sivatheres*. The *Hylaspitherium grande* is known from upper molars, mandible, calcaneum, and a proximal phalange. The author considers it possible that more abundant materials may place the species in a new genus.

Bramatherium is another genus of four-horned ruminants, distinguished by the arrangement of the horns. The only species known is the *B. perimense* of Falconer, and no new specimens have been found since the type was first described by that author. The horns, as is well known, consist of a conjoined anterior pair rising between the orbits and a second pair of large size rising from distinct bases at the sides of the occiput.

Sivatherium giganteum is only noticed in so far as Mr. Lydekker's views differ from those of previous writers, and to describe some teeth, vertebræ, and metapodial bones. The author differs from Dr. Murie, who regarded *Sivatherium* as most nearly allied to *Antilocapra*, because it is only in *Sivatherium*, the giraffe, the Irish elk, the true elk, and some other deer that the lobes of the molars are oblique to the long axis of the teeth, so as to overlap one another, while their enamel has a rugose structure. In *Antilocapra* and all cavicorn ruminants the enamel of the molars is nearly smooth and the lobes of the teeth are always set straight, so as never to overlap. The memoir concludes with seven plates, illustrative of teeth, cervical vertebræ, and metapodial and podial bones.

The term Selenodont Suina is used to define an extinct group of pig-like Ungulata which have the inner pair of cusps of the upper molars of crescentic form; and this group in India comprises *Anthracootherium* and *Hyopotamus*, which the author believes may eventually have to be united. Another family is represented by *Mivotherium*, and a third by *Diplopus*. The second or tetracuspitate division of the Selenodont group comprises the Merycopotamidæ and the Oreodontidæ, and a third division includes the Anoplotheres. The author observes that the Hyopotamids pass insensibly into the genus *Cainotherium*, which is a true ruminant; but the Oreodons are probably the progenitors of the ancestors of the camel, and the Anoplotheres are as closely related to the ruminant Xiphodons. Feeding for the most part on food that required fine trituration, their snouts are shorter than in the true pigs.

The account of the Anthracotheridæ, which belong to a group in which the upper molars have five cusps, commences with the typical genus *Anthracootherium*, which is met with throughout the Pliocene period. The Indian forms are *Anthracootherium hyopotamoides* of Lydekker and *Anthracootherium silistrense* of Pentland. This latter species, which has numerous synonyms, is known from the upper molars, which were first figured by the Geological Society in 1829, and the mandible. The second species is founded on an upper

molar tooth which has some characters approximating it to *Hypopotamus*. *Hypopotamus* is widely distributed in America, India, and Europe. Both the Indian species *Hypopotamus giganteus* and *H. paleindicus* are of older Pliocene age; they are both known from molar teeth and fragments of the mandible, so that beyond presenting very characteristic shapes they do not throw much light upon this generic type. The tetracuspidate *Merycopotamus dissimilis* was a four- or five-toed pig about the size of a wild boar. The anterior premolars are pointed, like those of *Anthracotherium* and *Hypopotamus*, and the cranium greatly resembles that of the latter genus, and in so far as it diverges from *Hippopotamus* it approximates to *Anthracotherium*; yet the author is disposed, from the character of the molars, to think it most closely related to the Anthracotheridæ and Oreodontidæ. *Chæromeryx silistrensis* is only known from a fragment of a jaw with three molars. *Hemimeryx Blanfordi* is a new type founded upon isolated molar teeth; it is most closely related to *Chæromeryx* and *Merycopotamus*, and has some relation to the Anoplotheres. *Sivameryx sindiensis* is another type founded on isolated teeth; it is larger than *Chæromeryx*, and also resembles *Merycopotamus*. The Oreodonts are represented by a species of the American genus *Agriochærus*; and the ruminant section is indicated by a single molar named *Pro-palæomeryx sivalensis*, and is considered to be most nearly related to a European species of *Palæomeryx*, and to form a link between the giraffe and the true deer. The memoir concludes with the usual bibliography, and is illustrated with three plates of teeth.

It is difficult to speak of Mr. Lydekker's merits as an anatomist, for he is unfortunate in having published work that was immature, so that now the corrections are unpleasantly numerous; but then the scientific fidelity of which these corrections are evidence is no small merit. We cannot so unreservedly commend the author's method; his critical acumen is excellent, but he does not always seem at his ease in dealing with the writings of others. Frequently voluminous discussions occur when the same result might have been attained in a few sentences. And the memoirs seem written on the supposition that the reader has the resources of the Indian Museum before him, and that the illustrations leave nothing to be desired. In other words, there is not that laborious description of materials other than teeth which we think necessary; and the result is that we are often unable to judge critically of much of the author's labours or to use them fully. If it should be urged that they make no pretence to be more than contributions to palæontology made for the Geological Survey of India, we would say that the acumen displayed by the author leads us to believe him capable of work of a yet higher order, and that science does not gain by restricting the palæontologist to the task of being a lantern-carrier for his geological comrade. The memoirs, however, are valuable contributions to palæontology; and the author is to be congratulated on the progress made with a difficult subject. *

MISCELLANEOUS.

Note on the Intelligence of the American Turret-Spider.

THE Rev. Dr. H. C. McCook exhibited nests of *Tarentula arenicola*, Scudder, a species of ground-spider of the family Lycosidæ, popularly known as the Turret-Spider. These nests, in natural site, are surmounted by structures which quite closely resemble miniature old-fashioned chimneys, composed of mud and crossed sticks, as seen in the log cabins of pioneer settlers. From half an inch to one inch of the tube projects above ground, while it extends straight downwards twelve or more inches into the earth. The projecting portion or turret is in the form of a pentagon, more or less regular, and is built up of bits of grass, stalks of straw, small twigs, &c. laid across each other at the corners. The upper and projecting parts have a thin lining of silk. Taking its position just inside the watch-tower, the spider leaps out and captures such insects as may come in its way. The speaker has found nests of the species at the base of the Allegheny Mountains near Altoona, and in New Jersey on the seashore. In the latter location the animal had availed itself of the building-material at hand, by forming the foundation of its watch-tower of little quartz pebbles, sometimes producing a structure of considerable beauty. In this sandy site the tube is preserved intact by a delicate secretion of silk, to which the particles of sand adhere. This secretion scarcely presents the character of a web-lining, but has sufficient consistency to hold aloft a frail cylinder of sand and silk, when the sand is carefully scooped away from the site of the nest.

A nest recently obtained from Vineland, N. J., furnished an interesting illustration of the power of these araneids to intelligently adapt themselves to varying surroundings, and to take advantage of circumstances with which they certainly could not have been previously familiar. In order to preserve the nest, with a view to study the life-history of its occupant, the sod containing the tube had been carefully dug up and the upper and lower openings plugged with cotton. Upon the arrival of the nest in Philadelphia the plug guarding the entrance had been removed, but the other had been forgotten and allowed to remain. The spider, which still inhabited the tube, immediately began removing the cotton at the lower portion, and cast some of it out. But, guided apparently by its sense of touch to the knowledge that the soft fibres of the cotton would be an excellent material with which to line its tube, it speedily began putting it to that use, and had soon spread a soft smooth layer over the inner surface and around the opening. The nest, in this condition, was exhibited and showed the interior to be padded for about 4 inches from the summit of the tower. Dr. McCook pointed out the very manifest inference that the spider must for the first time have come in contact with such a material as cotton, and had immediately utilized its new experience by substituting the soft fibre for the ordinary silken lining, or rather adding it thereto.—*Proc. Acad. Nat. Sci. Philad.*, June 19, 1883, p. 131.

Complete Biological Evolution of the Elm-tree Aphids (*Tetraneura ulmi*, Aut.). By M. J. LICHTENSTEIN.

For several years past I have communicated to the Academy some new views concerning the biological evolution of the Aphides. These views have been rejected by some entomologists and received with favour by others. Amongst the latter, Prof. Kessler, of Cassel, has done me the honour of placing "Confirmation of the Lichtenstein Theory" as a subtitle to the last observations which he has published on the Aphides of the cornel and apple-tree (*Aphis lanigera*).

Another entomologist, Prof. G. Horvath, Director of the Phylloxera station in Hungary, observed, in the autumn of 1882, that the Aphides which live during the summer at the roots of the maize became winged and repaired to the trunks of the elm trees, upon which they deposited individuals wanting rostra and sexual. Believing, from the nature of the plant attacked, that he had to do with the Aphis of the maize-root (*Pemphigus zea-maydis*, Léon Dufour, according to Lon), he published, in a French entomological Review, the interesting fact which he had observed, concluding thus:—"The *Pemphigus* of the maize-root migrates from its subterranean habitat to the trunks of elm trees; but I do not know what becomes of it afterwards."

On this information I had to try to obtain a counter-proof. As the elm, here as in Hungary, only nourishes one species of *Pemphigus* (*P. pullidus*, Haliday, sub *Eriosoma*), I had no doubt that by taking this species as it emerged from the gall, and forcing it to deposit its eggs upon the maize, I should obtain the subterranean phase observed by Horvath.

I met with complete failure, however; not one of the thousand little *Pemphigi* which I placed upon the maize-roots attached itself. I had, nevertheless, carried on my experiments with the greatest care, by growing the maize in glass vessels, which permitted me to observe with the lens the roots pressed against the transparent sides of the vessel.

I was greatly disappointed; but as I had my arrangements ready, I extended the experiments to the other species which live on the elm; these are four in number—two *Schizoneura*, *ulmi* and *lanuginosa*; two *Tetraneura*, *rubra* and *ulmi*. The first three species died, like the *Pemphigus*, without attaching themselves to the roots of the maize; but, to my great satisfaction, I saw the larvæ of the fourth species, *Tetraneura ulmi*, attach themselves and rapidly increase in size, covering themselves with the woolly or cottony secretion so common among this group of insects. I wrote immediately to M. Horvath, "The counter-proof of your discovery did not succeed with me as regards the *Pemphigus* of the elm. Are you sure that you are not mistaken? Send me the winged insect which migrates from the maize-roots to the elm."

Thanks to the method of preservation which I had invented for the transmission of Aphides in a drop of Canada-balsam, between

two thin slices of mica the size of a postage-stamp, my colleague at Budapest sent me what he believed to be *Pemphigus zea-maydis*. As I thought, he was mistaken; the insect which he discovered on the roots of the maize is a *Tetraneura*, since the hind wings have only one nervure instead of two, as the species of the genus *Pemphigus* should have. Moreover, the size, shape of the antennæ, and absence of hairs on the abdomen proved that it was *Tetraneura ulmi* and not *Tetraneura rubra*, of which I had discovered the subterranean habitat in the preceding year, and which lives at the roots of the dog's grass.

Here, then, we have the complete history of the biological evolution of a second Aphis of the elm, discovered, so to speak, simultaneously in France and Hungary, and which had already been elucidated by Prof. Kessler, of Cassel, placed now beyond doubt. In the train of *Phylloxera quercus*, *Anoploleura lentisci*, and *Tetraneura rubra*, of which I made known the migrations from one species of oak to another, or from the roots of grasses to the mastic-tree and the elm, we have *Tetraneura ulmi*, which migrates in June from the elm-galls to the roots of the maize, and which returns in October in the pupiferous form, bringing forth the sexual individuals upon the trunks of the elms.

As to *Pemphigus zea-maydis*, its gallicolous form (that is to say, the foundress and emigrant phases) still remains to be discovered.—*Comptes Rendus*, July 16, 1883.

Elevated Coral Reefs of Cuba. By W. O. Crosby*.

Mr. Crosby describes in this paper the elevated coral reefs of Cuba, and draws from them the apparently well-sustained conclusion that they indicate a slow subsidence during their formation, and hence, further, that Darwin's theory of the origin of coral islands is the true theory. The *lowest* reef-terrace of the northern side of the island has a height of 30 feet, and varies in width from a few rods to a mile; it was once plainly the fringing reef of the shore. The *second* reef-terrace rises abruptly from the level of the lower to a height of from 200 to 250 feet, and bears evidence of having been of like origin with the lower. The altitude of the *third* reef is about 500 feet; and the *fourth* has a height east of Baracoa, near the Yumuri River, "of probably not less than 800 feet." These old reef-terraces extend, "with slight interruptions, around the entire coast of Cuba; and in the western part of the island, where the erosion is less rapid than further east, they are the predominant formation, and they are well preserved on the summits of the highest hills. Mr. Alexander Agassiz states that the hills about Havanna and Matanzas, which reach a height of over 200 feet, are entirely composed of reef-limestone."

* Proc. Boston Soc. Nat. Hist.

In the precipitous mountain called El Yunque (the Anvil), five miles west of Baracoa, reef-limestone, 1000 feet thick, constitutes the upper half of the mountain, the lower part, on which the reef rests, consisting of eruptive rocks and slates; and originally the upper limit of this modern limestone formation must have been 2000 feet above the sea-level. Mr. Sawkins gives 2000 feet as the maximum thickness of the Jamaica elevated coral reefs above the sea.

Evidence that the reefs were not formed during a progressive rising of the land is drawn from the thickness of the reefs. Mr. Crosby observes that the reefs reaching to a height of 500 and 1000 feet, if not also to that of 2000 feet, show, by the remains within them, that they were made chiefly of reef-building corals, and hence that they were not begun in deep water, as is assumed in the theory of Mr. Agassiz, but that they were made in shallow water during a progressive subsidence. Mr. Crosby concludes as follows:—

“We have then apparently no course but to accept Darwin’s theory as an adequate explanation of the elevated reefs of the Greater Antilles, and therefore to admit that the upheaval of this portion of the earth’s crust has been interrupted by periods of profound subsidence during which the reefs were formed. The subsidence of 2000 feet, of which El Yunque is a monument, must have reduced the Greater Antilles to a few lines of small but high and rugged islands; but, as Mr. Bland has shown, this fully accounts for the absence in these immense tracts of all large animals, although they were abundant here in Pliocene and earlier times.”

The writer adds here the following objections to the theory of the formation of coral atolls in deep waters out of the calcareous secretions of deep-water life:—(1) It is very improbable that submarine eruptions ever make the large and well-defined craters, like those of subaerial action, which are appealed to in order to explain the lagoon feature of atolls; (2) Many coral atolls are twenty miles or more in diameter, which is vastly larger than the largest of craters; (3) The atolls are never circular, and the larger have the irregularities of outline or diversities of form characterizing other large islands of the ocean; (4) In the actual reefs and islands of the Feejee group (see the map of the islands in the writer’s ‘Corals and Coral Islands’) all the conditions, from the first stage to that of the almost completed atoll, are well illustrated, one island having only a single peak of rock within the lagoon, not $\frac{1}{100}$ of the whole area, which a little more of subsidence would put beneath the waters and leave the lagoon wholly free.—J. D. DANA, in *Silliman’s American Journal* for August 1883.

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XXXII.—*Contributions to Micro-Palæontology.*—On *Stenopora Howsii*, Nich., with Notes on *Monticulipora? tumida*, Phill., and Remarks on *Tabulipora Urii*, Young. By H. ALLEYNE NICHOLSON, M.D., D.Sc., Regius Professor of Natural History in the University of Aberdeen.

[Plate X.]

1. *Stenopora Howsii*, Nich.

IN a recent visit to Northumberland I was fortunate enough to obtain a considerable number of specimens of the singular *Stenopora Howsii*, Nich., of which I had previously published a short provisional description and figures, based upon a magnificent example in the cabinet of Mr. Richard Howse, F.G.S. (see 'The Genus *Monticulipora*,' p. 83, fig. 12, 1881). Having, therefore, now had the opportunity of examining a large series of specimens in all stages of growth, and also of preparing a number of thin sections, I purpose giving on the present occasion a fuller description of the characters of this remarkable type.

As regards its essential specific characters the corallum of *Stenopora Howsii* is ramose, with subcylindrical or flattened branches, which are mostly from $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter.

The walls of the corallites are completely amalgamated, and the calices are polygonal, comparatively thin-walled, and (including the wall) mostly about $\frac{1}{16}$ inch in diameter, clusters of slightly larger tubes, intermixed with small tubuli, occurring here and there. Minute interstitial tubes are present at the angles of junction of many of the large corallites, or are collected into stellate groups or "maculæ." The walls of the corallites are marked with conspicuous periodic enlargements or annulations, and the tabulæ are usually perforated by a central aperture. Mural pores have not been detected.

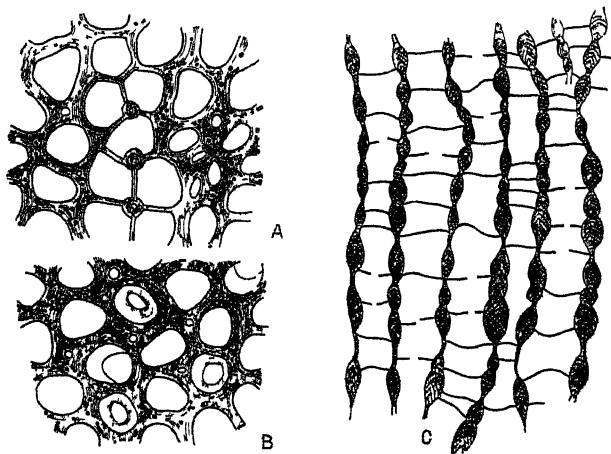
As regards *external characters*, British examples are always ramose, the branches being usually compressed or flattened, though sometimes quite cylindrical, and often exhibiting slight tumid enlargements at intervals. The stems vary in diameter from 2 to 7 lines; and the Arctic specimens, which I shall subsequently describe as forming a distinct variety, are still more massive, or even become sublobate. The calices are polygonal and decidedly thin-walled (especially as compared with the calices of the associated *Monticulipora? tumida*, Phill.). In size they are mostly from $\frac{1}{16}$ to $\frac{1}{8}$ inch in diameter; but not uncommonly groups of corallites slightly larger than the average may be present here and there, and there is always a variable number of small interstitial tubuli. These latter are not only disseminated among the larger tubes, but are commonly aggregated into star-shaped "maculæ" (Pl. X. fig. 2), which may be a line or more across, but are not, so far as I have seen, elevated above the general surface. At other times the tubuli occupy irregular and narrow linear tracts. The surface is not markedly roughened or spinulose, though all well-preserved examples exhibit under the microscope many small blunt tubercles on the lips of the calices. Lastly, many of the calices show the marked feature that their floor is formed by a tabula which is perforated by a central aperture (Pl. X. figs. 2 and 3).

As regards *internal structure*, the corallites exhibit marked differences according as they are examined in the axial region or in the periphery of the branches. Thus, in the axial region the corallites are at first vertical, but soon bend gradually outwards, and they are here always polygonal and mostly thin-walled (Pl. X. fig. 9). The lines of demarcation between contiguous tubes have not yet been obliterated, and when the tubes are thickened (as they sometimes are) the thickening is uniform and not intermittent. Moreover the tabulæ of the axial region are always very sparsely developed, and, when present, are always imperforate and complete.

On the other hand, in the final or peripheral portion of

their course the corallites assume their mature characters, and now exhibit the features peculiar to *Stenopora*. As regards their direction, they are now bent outwards approximately at right angles to the axis of the branch, and their walls are now thickened periodically by annular enlargements, which are placed at corresponding levels in contiguous tubes. Hence, in the broken ends of the branches, the corallites show a highly characteristic beaded appearance; and in thin sections (fig. 1, C) the walls are seen to have a marked moniliform structure, narrow unthickened segments alternating with annular thickenings or nodes.

Fig. 1.



Stenopora Howsii, Nich., from the Carboniferous rocks of Redesdale. A. Tangential section traversing in part the unthickened segments of the tubes. B. Tangential section traversing the thickened segments of the tubes. C. Portion of the peripheral region of a transverse section, showing the thickenings of the walls and the perforated tabulae. All the figures are enlarged about eighteen times.

As regards the minute structure of the walls of the corallites, the thickened nodes are formed (as in the species of *Stenopora* generally) by the growth of successively superimposed thin layers of sclerenchyma, each layer forming a kind of conical cap, as seen in section (Pl. X. fig. 10). The walls of adjacent corallites are apparently so amalgamated and fused together that no traces can, as a rule, be detected of the original boundary-lines of the separate tubes. In some cases, however, in tangential sections it is possible, by means of a careful management of the light, to recognize the original

polygonal lines of demarcation of the different corallites ; but even in this case such lines only appear as clear spaces (Pl. X. fig. 6). In the structure of the wall, therefore, *S. Howsii* agrees with such forms as *Stenopora tasmaniensis*, Lonsd., and differs from such as *S. ovata*, Lonsd., and *S. crinita*, Lonsd., the boundary-lines in these latter species remaining permanently recognizable as distinct dark lines marking off the originally polygonal corallites*.

The tabulæ of the peripheral region of the corallum are exceedingly characteristic, the great majority (possibly all) being perforated by a central oval, or subcircular, or reniform aperture, the structure, however, being wholly unlike that which characterizes the genus *Prasopora*, Nich. & Eth. As seen in tangential sections (Pl. X. figs. 4, 7, and 8) the tabulæ appear as circular ledges, surrounding the visceral chambers, and each perforated by a central aperture, the immediate margin of which is somewhat thickened. As seen, on the other hand, in longitudinal or transverse sections (Pl. X. figs. 9 & 10), the tabulæ present themselves as so many pairs of short, nearly horizontal, or somewhat deflexed processes, the free ends of which, where they abut upon the central aperture, are slightly thickened or bulbous. Some of the tabulæ appear to be complete and to pass completely across the visceral chambers of the corallites. It is probable, however, that all the tabulæ in the peripheral region are really perforated, and that the apparent completeness of some of them is merely due to the fact that the line of section at that particular point traversed the visceral chambers excentrically, and therefore did not pass through the central perforations of the tabulæ. In any case, the tabulæ mostly spring from the unthickened segments of the corallites, and are mostly about $\frac{1}{16}$ inch apart. It is also the last-formed tabula which appears as the perforated diaphragm at the bottom of so many of the calices.

Finally, in tangential sections the appearances presented vary according as the section passes through the tubes at the level of their thickened nodes, or at that of the unthickened internodes, the resulting differences being usually observable in different portions of the same slice. Thus, if the section should traverse the unthickened segments of the corallites (as seen in the lower part of fig. 1, A, and in Pl. X. figs. 4 and 5), the tubes appear to be comparatively thin-walled and approximately polygonal, and there are comparatively few and

* The occurrence of such a well-marked difference of structure as that above noted, in species otherwise so closely allied, would lead us to suppose that it is, perhaps, hazardous to lay great stress upon the amalgamation or non-amalgamation of the walls of the corallites as a point of generic distinction.

small dark spots marking the presence of spiniform processes or small tubuli. Very commonly, however, there are seen at the angles of junction of the corallites large, round, very thick-walled tubes, each with a central dark spot or a minute median opening. It is difficult to be certain what these circular thick-walled tubes may be; but they are very characteristic of most tangential sections of *S. Howsii*, and they perhaps represent a special series of corallites. On the other hand, if the section traverse the thickened nodes of the corallites (as in fig. 1, B, and in Pl. X. figs. 7 and 8), the tubes appear to be thick-walled, and we observe in general the following objects:—(1) the oval or circular apertures of the ordinary corallites, some of these being occupied by the ring-like perforated tabulæ; (2) the apertures of small interstitial tubuli, either scattered here and there (Pl. X. fig. 8) or aggregated into "maculæ" (Pl. X. fig. 7); (3) numerous irregularly distributed dark spots in the walls of the corallites, which often exhibit a minute clear spot in the centre, and which are doubtless the sections of hollow spines; and (4) large circular thick-walled tubes, such as have been previously alluded to, which present a central dark spot or clear space, and usually a well-marked dark margin (Pl. X. fig. 6).

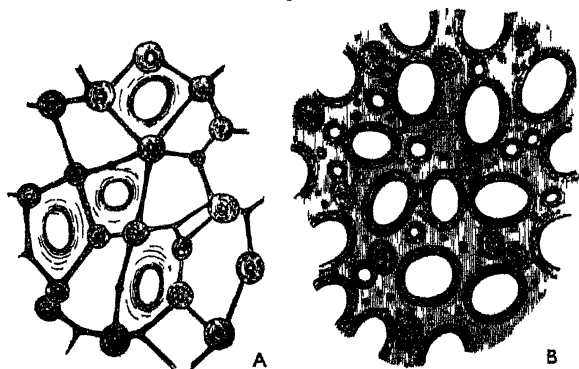
As regards the *affinities* of *Stenopora Howsii*, it is most nearly allied to *S. tasmaniensis*, Lonsd.; but the latter is easily distinguished by the smaller number and much larger size of its spiniform tubes, and by the fact that the tabulæ of the peripheral region are few in number, and, so far as my observations have gone, imperforate. The form, however, which it is most difficult to separate from *S. Howsii* is that which has been generally recognized as *Monticulipora* (?) *tumida* of Phillips; but before discussing this point I may briefly describe a remarkable form of *S. Howsii* from the Arctic regions.

2. *Stenopora Howsii*, var. *arctica*, Nich.

There exist in the magnificent collection of the British Museum several specimens of a large *Stenopora* from the Carboniferous rocks of Feilden Isthmus, which were collected in the Nares expedition. By the kindness of my friend Dr. Henry Woodward, F.R.S., I have been permitted to examine these specimens, and at once satisfied myself as to their substantial identity with the *Stenopora Howsii* of the Carboniferous rocks of Northumberland. They exhibit, however, certain subordinate points of distinction from the British types, and I think it best therefore to mark the existence of these by the addition of a varietal name.

S. Howsii, var. *arctica*, is a larger and more massive form than the normal examples of the species, but its general mode of growth is the same, and there is no essential difference as regards their general structure. Tabulæ are, however, less abundantly developed in the peripheral region of the corallum (Pl. X. fig. 11), and are therefore separated by wider intervals. On the other hand, there is a specially extensive development of the curious thick-walled tubes which I have described as occurring in the normal form of *S. Howsii*. These remarkable structures are best observed in tangential sections, whether these traverse the corallum at the level of the unthickened segments of the corallites (fig. 2, A) or at that of the thickened nodes (fig. 2, B). In longitudinal

Fig. 2.



A. Part of a tangential section of *Stenopora Howsii*, var. *arctica*, taken at the level of the unthickened segments of the tubes, enlarged twenty-four times. B. Another part of the same section, taken at the level of the thickened parts of the tubes, similarly enlarged.

sections (Pl. X. fig. 11) the same structures appear as tubes running in the thickness of the walls of the ordinary corallites.

While these singular tubes are remarkably abundant, the interstitial tubuli which are such a striking feature in the normal form are here somewhat diminished in number. The chief point, however, by which *S. Howsii*, var. *arctica*, is distinguished from the type of the species is that the walls of the corallites are decidedly thicker and the visceral chambers more contracted than in the latter, while each visceral chamber is surrounded by a ring-like investment of fibrous sclerenchyma (fig. 2, B).

Formation and Locality. The type of the species occurs in

the Carboniferous rocks of Redesdale, in Northumberland (coll. Richard Howse and H. A. Nicholson). The Arctic specimens (var. *arctica*) are from the Carboniferous rocks of Feilden Isthmus (lat. $82^{\circ} 43' N.$), and were collected by Capt. Feilden, as naturalist to the Nares expedition (coll. Brit. Mus.).

3. Notes on *Monticulipora*? *tumida*, *Phill.*

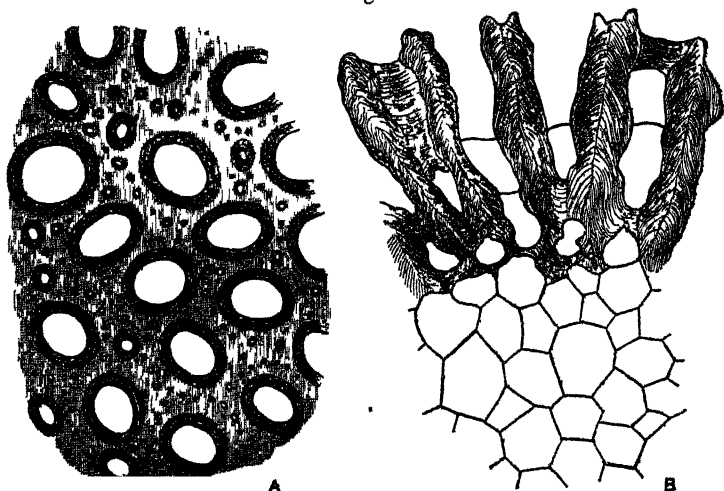
The general characters and minute structure of the form which I regard as being the *Calamopora tumida* of Phillips have been previously described by me ('The Genus *Monticulipora*,' p. 120). After an examination of an enormous number of additional specimens, I have only little of structural importance to add to the description formerly given; but I should wish to make some remarks as to the affinities and synonymy of the species.

Monticulipora? *tumida*, *Phill.*, is an essentially dendroid species, but, like other ramose forms, it often begins its existence in the shape of a thin crust growing upon the stem of a Crinoid or some similar object. The stems are mostly between 1 and 2 lines in diameter, but may reach at least 3 lines in diameter. The calices are rounded, oval, or sub-polygonal, with very thick walls, their actual *apertures* being round or oval and mostly between $\frac{1}{30}$ and $\frac{1}{20}$ inch in diameter. The lips of the calices are raised into prominent rims, which slope down by a deeply concave edge to the margin of the actual visceral chamber, thus giving rise in some cases to the appearance of perforated diaphragms at the bottom of the calices; but I am satisfied that this is the true explanation of the appearances in question. The prominent intercalicine ridges always support, in unrubbed examples, a row of prominent blunt spines, which can sometimes be observed to open by distinct circular apertures, and which give to the surface a characteristic rough or spinulose aspect and feel. Lastly, minute corallites or interstitial tubes are commonly developed at the angles of junction of the larger corallites, or are aggregated to form distinct maculæ.

With regard to the *internal structure* of the corallum, tangential sections (fig. 3, A) show that the walls of the corallites are completely amalgamated in the peripheral region, the conjoint walls being usually about $\frac{1}{120}$ inch across, while the visceral chambers average about $\frac{1}{30}$ inch in diameter. The visceral chamber of each corallite is surrounded by a thickened fibrous layer, and the interspaces between the corallites are filled with clear sclerenchyma, traversed by rows of dark-coloured hollow spines. Minute corallites or tubuli are also

developed in variable amount, and often appear in clusters. Tangential sections taken a little below the surface show, further, that the corallites gradually become less and less thickened, and more and more polygonal in outline, while traces of the original lines of demarcation between adjacent tubes can be made out, and the spiniform tubules gradually disappear. In the axial region of the corallum, as shown in longitudinal or transverse sections (fig. 3, B), the corallites, finally, become completely separate, having now thin walls and a polygonal outline.

Fig. 3.



Monticulipora? tumida, Phill., from the Carboniferous rocks of Redesdale, Northumberland. A. Part of a tangential section, enlarged twenty-four times, showing the large and small corallites, and the rows of interstitial spiniform tubules. B. Part of a transverse section, enlarged twenty-four times, showing the polygonal and thin-walled axial tubes and the thickened walls and complete tabulae of the peripheral portions of the corallites.

The only two remaining structural points to notice concern the nature of the tabulae and the thickening of the walls of the mature corallites. As to the first of these two points, it is quite certain that the tabulae are essentially and habitually *complete* and *imperforate* (fig. 3, B). In no single longitudinal or transverse section have I ever detected an incomplete tabula, and out of a large number of tangential sections I have only once met with an instance of a perforated tabula, and then only in one or two corallites.

As to the second point, the walls of the corallites in the peripheral region of the corallum are invariably greatly thick-

ened (fig. 3, B); and they sometimes exhibit a sort of periodic variation in the amount of this thickening, causing the walls to be thicker in some parts than in others. In no case, however, does the wall come to consist of a series of unthickened segments separated by thickened annular nodes; so that neither in rough fractures nor in longitudinal sections do we find the walls of the corallites exhibiting a moniliform or beaded aspect.

This last point brings us to consider for a moment the generic position of this species. There can be no doubt that in its general characters, *Monticulipora? tumida*, Phill., makes a very close approach to such species of *Stenopora* as *S. tasmaniensis*, Lonsd., and, still more, *S. Howsii*, Nich. This was formerly pointed out by myself; and, after a renewed investigation, I can only repeat that "so far as our present knowledge goes, the only points which would definitely separate *M. tumida*, Phill., from *Stenopora* are, that it certainly shows no traces of the peculiar moniliform and periodic thickening of the walls of the corallites which is characteristic of the latter genus, and that there is no evidence as to the presence of mural pores" ('The Genus *Monticulipora*,' p. 124). The existence or non-existence of mural pores may be left out of account, however, as these structures are so difficult of detection; so that the structure of the wall alone remains to separate *M. tumida* from *Stenopora*. It must be added, however, that this last point is one so essentially characteristic of the genus *Stenopora*, Lonsd., that it would seem impossible to include under this name any type which did not exhibit this peculiar feature as regards the mature corallites.

The species from which it is most difficult to separate *M.? tumida* is *Stenopora Howsii*, and I may briefly summarize the chief points which distinguish them.

(a) *Dimensions of corallum*.—The corallum of *M.? tumida* is in general markedly smaller than that of *S. Howsii*, branches of the former being most commonly about a line and a half or two lines in diameter, whereas the stems of the latter average about four lines in diameter. Still, large stems of *M.? tumida* cannot by this character alone be separated from small stems of *S. Howsii*.

(b) The *calices* of *M.? tumida* are markedly thickened and usually circular or oval, whereas those of *S. Howsii* are comparatively thin-walled and are generally polygonal.

(c) The *lips of the calices* in *M.? tumida* carry numerous blunt spines, which in well-preserved specimens terminate in minute circular apertures, and which give to the surface a markedly rough and spinulose aspect. In *S. Howsii*, though

similar spines exist, they are comparatively small and short, the surface wanting, therefore, the rough appearance which exists in *M. ? tumida*.

(d) The *tabulæ* in the peripheral region of the corallum are few in number in *M. ? tumida*, and are almost invariably complete and imperforate. On the other hand, the *tabulæ* of the same region in *S. Howsii* are numerous, and are, mostly or wholly, perforated by central apertures. Hence many of the calices in this latter type have their floors formed by one of these perforated *tabulæ*.

(e) The *walls of the corallites* in the peripheral region of the corallum are in *M. ? tumida* greatly thickened, but the thickening is approximately uniform and shows no regular intermissions. In *S. Howsii*, on the other hand, the walls of the corallites in the same region are intermittently thickened, and thus assume a moniliform or beaded structure.

(f) *M. ? tumida* does not appear to possess the singular thick-walled circular tubes which are so commonly developed in *S. Howsii* at the angles of junction of the normal corallites.

As to the *synonymy* and nomenclature of *M. ? tumida*, a good deal of confusion has been caused by the fact (which I have only recently come to appreciate fully) that *M. ? tumida* and *S. Howsii* have hitherto been imperfectly or not at all separated from one another—this being not unnatural when it is remembered that the two commonly occur together and are externally very similar. Hence some observers have either included *both* types under the name of *M. tumida*, or have founded their descriptions of *M. tumida* upon specimens which really belong to *S. Howsii*.

It is quite clear that Phillips himself included at least two different forms under the name of *Calamopora tumida*. One form ('Geol. of Yorkshire,' pl. i. figs. 49–51) is almost certainly the form which I have, here and elsewhere, regarded as *Monticulipora tumida*. Another form (*ibid.* pl. i. figs. 52, 56, 57) may be taken, with an equal approach to certainty, to be the type which I have here called *Stenopora Howsii*. Under these circumstances, considering the very brief nature of the description given by Phillips, it would perhaps have been best to have suppressed the name of "*tumida*" altogether; but the wide currency which it has acquired renders this impossible. I shall therefore retain it for the species here so named; and in giving a synonymy of the species I should omit all the figures given by Phillips in plate i. of his 'Geology of Yorkshire,' except figs. 49, 50, and 51.

Again, it is difficult to avoid the conclusion that M'Coy, in his great work (Brit. Pal. Foss. p. 82), applied Phillips's name of "*tumida*" to the form which I understand to be *Stenopora Howsii*. This is shown partly by the fact that M'Coy only refers to one of Phillips's figures, that being fig. 52 (by obvious misprint given as fig. 25), which I regard as a figure of *S. Howsii*; and partly by the fact that his description applies admirably to *S. Howsii*, but not at all to the form which I take as *M. ? tumida*, Phill. Hence, if this view be accepted, the name of *Stenopora tumida*, M'Coy, must be omitted from the synonymy of *M. ? tumida*, Phill., sp., and must be given as a synonym of *Stenopora Howsii*, Nich., as the retention of the specific name of *tumida* for the latter would lead to hopeless confusion.

It would, further, seem probable that under the name of *Chaetetes tumidus*, Milne-Edwards and Haime included more than one form. The figure which they give in the 'British Fossil Corals' (pl. xlv. fig. 3) is apparently referable to *Stenopora Howsii*; but they probably had also examined the true *M. ? tumida*; and they certainly included under the same title the wholly distinct type described by De Koninck as *Calamopora inflata*, and by M'Coy as *Stenopora inflata*. It is therefore only in part that *Chaetetes tumidus*, E. & H., can be quoted as a synonym of *Monticulipora ? tumida*.

Finally, I may just add that I am inclined to think that the form described by Prof. De Koninck as *Monticulipora tumida* is really quite distinct from either of the British forms. M. De Koninck was good enough to furnish me with authentic specimens of the Belgian type; and though they are unfortunately in a state of preservation which has prevented my making thin sections of them, I have been led to the above conclusion from their general appearance, and especially from the fact that the corallites of the peripheral region are inclined to the surface at a much more acute angle than is the case in *M. ? tumida* or in *S. Howsii*, while that region of the corallum is itself much more contracted in proportion to the size of the stems.

4. Remarks upon *Tabulipora Urii*, Young.

Since the foregoing was written, I have had the opportunity of reading the interesting paper which Mr. John Young has just published (Ann. & Mag. Nat. Hist. Sept. 1883, p. 154) upon a Monticuliporoid from the Carboniferous rocks of Scotland, which he identifies with *Cellepora Urii*, Flem., and places in a new genus under the title of *Tabulipora*.

According to Mr. Young, this form is a dendroid coral of the usual type of the Monticuliporoids, but especially distinguished by the nature of its tabulæ. In the axial region the corallites are stated to be without tabulæ, while in the peripheral region the tabulæ are numerous and are perforated by "roundly crescentic" or "reniform" openings, which are so directed that "the concave edges of the opening in branching specimens is invariably turned towards the lower end of the branches." In longitudinal sections of the corallites the perforated tabulæ are stated to appear as "a series of small thin projecting points with a little rounded knob at their ends." It would further appear from Mr. Young's description that the walls of the corallites are not annulated in the peripheral region, and that mural pores are not present.

The perforated tabulæ render it clear that this form is distinct from that which I regard as *M. ? tumida*, Phill., and it only remains therefore to say a few words as to its relations to *Stenopora Howsii*. In so doing, the question of mural pores can be left out of account (as not detected in either form), and the only two features of importance which need be discussed are the tabulæ and the walls of the corallites. As regards *S. Howsii*, it is not uncommon for the central perforations of the tabulæ to have one margin slightly protuberant, and thus to become rudely reniform; but the curved edges of different perforations certainly do not point in any particular direction in any particular specimen, but, on the contrary, point in different directions. Apart from this, however, I cannot regard the mere presence of perforated tabulæ as sufficient to preclude the reference of *Tabulipora Uriei* to the genus *Stenopora*, Lonsd., since these structures exist in *S. Howsii*, and probably in other species of *Stenopora* as well. If, on the other hand, I rightly understand Mr. Young to state that the corallites in the peripheral region in *Tabulipora Uriei* have walls destitute of annular thickenings, then, certainly, this form cannot be referred to the genus *Stenopora*, since the moniliform or annulated wall is the most essential character of the latter genus.

Apart from the character just mentioned, *Tabulipora Uriei*, Young, would appear to be extremely similar to *Stenopora Howsii*, Nich., and if they had agreed in the structure of the wall, I should have been disposed to regard them as undoubtedly identical. Should this ultimately prove to be the case, I must frankly admit, however, that I shall not feel inclined to abandon my specific name in favour of that of "*Uriei*," Fleming. Nor, indeed, should I, under any circumstances, regard it as advisable to resuscitate Fleming's species, even if such

a resuscitation could be effected with the certainty that we had to deal with Fleming's original specimen or specimens. In this repugnance to the revival of a title so defined originally as to be absolutely undeterminable, I think I should not find myself singular, especially when it is recollected that Fleming's entire description ('*Brit. Animals*,' p. 533) was as follows:—" *Cellepora Urii*. Branched, round, about a quarter of an inch in diameter, form round.—Millepore, *Ure*, *Ruth.* 228, t. xx. f. 1." If, therefore, it should be proved that *Tabulipora Urii* (as described by Mr. Young) is a good species, it should, in my opinion, stand as *T. Urii*, Young, and not as *T. Urii*, Flem. It may just be added that even admitting that Ure gave, to begin with, a good figure of his "Millepore," this is not one of the cases in which a figure can be used as a basis for specific identification, since all modern palæontologists would, I think, admit the total inadequacy of a mere figure of the external appearance of a specimen of one of the dendroid Monticuliporoids or Stenoporoids as a guide for specific, or even generic, determination.

EXPLANATION OF PLATE X.

- Fig. 1.* A fragment of *Stenopora Howsii*, Nich., of the natural size. From the Carboniferous shales of Redesdale, Northumberland.
- Fig. 2.* Portion of the surface of the same, enlarged twelve times.
- Fig. 3.* A single calice, enlarged twenty-four times, showing a perforated tabula.
- Fig. 4.* Portion of a tangential section, taken across the unthickened segments of the tubes, enlarged twelve times.
- Fig. 5.* Part of the same section, enlarged twenty-four times, showing interstitial spiniform tubes.
- Fig. 6.* Part of another tangential section, enlarged forty-five times, showing the original bounding-lines of the corallites.
- Fig. 7.* Part of a tangential section, taken across the thickened portions of the corallites, at a point where a "macula" is present, enlarged twelve times.
- Fig. 8.* Another tangential section, where no "macula" is shown, similarly enlarged.
- Fig. 9.* Part of the centre of a transverse section, showing the thin-walled polygonal axial corallites, enlarged twelve times.
- Fig. 10.* Part of the periphery of a transverse section, enlarged twenty-four times, showing the beaded structure of the walls and the perforated tabulae.
- Fig. 11.* Part of the periphery of a transverse section of *S. Howsii*, var. *arctica*, enlarged twenty-four times.

XXXIII.—*Neuroptera of the Hawaiian Islands*.—Part II.
Planipennia, with General Summary. By ROBERT
 McLACHLAN, F.R.S. &c.

THE materials for this group are very limited, consisting only of one species of Hemerobiidæ, four of Chrysopidæ, and one of Myrmeleontidæ.

The only interesting feature consists in the existence of aberrant and probably strictly endemic forms of Chrysopidæ.

Hemerobiidæ.

Megalomus, sp.

One ♀, gummed on card (*Blackburn*, No. 25).

I do not feel justified in naming and describing this insect in the absence of the other sex or of more materials, especially as there are no striking colour-characters. It is of the size and form of the European *M. hirtus*, L., and also resembles it in colour to some extent; but the transverse markings on the anterior wings are less pronounced, and the apical spots on the posterior wings are wanting. It would not be safe to hazard an opinion as to the species being endemic or otherwise. Small Hemerobiidæ are liable to be carried on plants and shrubs when in the pupa state.

Chrysopidæ.

ANOMALOCHRYSA, n. g.

In form and facies similar to *Chrysopa*, but the wings have *three or more series of gradate nervules* (at any rate in the anterior pair), which are sometimes irregular; dividing nervule of the third cubital cellule angular beneath (thickened on its inner side), so that the cellule it forms is triangular; subcosta confluent with the costa before the apex of the wing.

Antennæ scarcely longer than the wings.

Labrum truncate (this character a little doubtful owing to the condition).

Tarsal claws dilated internally at the base.

Abdomen of male *ending in a dilated flattened superior plate, beneath which is an elongate triangular inferior appendage*, the whole structure causing the apex to appear dilated.

The characters emphasized in the foregoing description indicate structures aberrant for the family as a whole; but nevertheless the two species have the aspect of *Chrysopa* in all respects, and should be placed near *Hypochrysa*.

Anomalochrysa hepatica, n. sp.

Body liver-coloured, with a purplish tint (probably varied with paler on the pectus &c. in the living insect). Head polished, paler posteriorly; face yellowish (at any rate in the male); palpi brownish; antennæ brownish (paler in the male and darker in the female in the pair before me), the basal joint strongly bulbous.

Pronotum scarcely longer than broad, hardly narrowed anteriorly; a very deep transverse impression before the posterior margin.

Legs pale yellow, the tarsi (especially the apical joint and claws) darker; posterior tibiæ with a fuscous line above (more distinct in the female).

Abdomen of the male clothed above with rather long and dense hairs directed toward the base (in the female there are only a few scattered short hairs directed in a contrary manner). In the male the terminal segment forms a large nearly circular plate, shallowly concave above, but with an incrassate rim; beneath this plate is the large broadly triangular inferior appendage, which nearly equals the superior plate in length, and is obtuse and inturned at its apex; between these parts is seen a styliform process (penis?), curved downward, its apex resting in the inturned apex of the inferior appendage (the lateral edges of this appendage are thickened and concave at the base).

Wings vitreous, shining, and iridescent, moderately elongate, the apex obtuse (the posterior considerably narrower); neuration olivaceous (probably greenish in life), but appearing darker in certain lights; the base of the radius and the commencement of the sector (which is thickened at that part) blackish; all the neuration furnished with rather long black hairs, each of which proceeds from a black point or minute tubercle; pterostigmatic region olivaceous, rather long, the subcosta ending with it; five series of gradate nervules in the anterior wings, of which the inner consists of about twelve nervules, the second of about seven or eight, the third of six or seven, the fourth and fifth of about seven each (but the intermediate series are more or less irregular); about twenty-five antepterostigmatic costal nervules; in the posterior wings there are only four series of gradate nervules.

Length of body 8 millim.; expanse, ♂ 27 millim., ♀ 30 millim.

"Occurs at an elevation of about 4000 feet on Haleakala, Maui" (*Blackburn*, one ♂, one ♀, No. 30).

Anomalochrysa rufescens, n. sp.

Body pale reddish. Head polished; antennæ, palpi, and legs concolorous with the body; the basal joint of the antennæ strongly bulbous; claws darker.

Pronotum longer than broad, slightly narrowed anteriorly, with a deep transverse impressed line before the posterior margin.

Abdomen apparently varied with darker (blackish?), and with pale margins to the segments; hairy clothing slight and ordinary. In the male the apex has an analogous formation to that seen in *A. hepatica*; but the superior plate is more oval and less conspicuous (inferior appendage probably narrower, but uncertain, owing to the method of preparation of the specimen).

Wings vitreous, iridescent, those of the male distinctly shorter and broader than in the female; in the male *there is a peculiar formation of the costal margin* of the anterior pair; this is shallowly excised soon after the base, and before the pterostigmatic region it is rather suddenly elevated and incassated, after which the costal area is very narrow (in the posterior wings the only peculiarity is a thickening and slight elevation of the costa at the corresponding point; in the female there is a slight thickening of the costa in both pairs of wings, but with no sudden elevation); neuration strong, olivaceous (probably decidedly greenish in life), set with short black hairs; pterostigmatic region dingy yellowish (the texture at this region is altered and is subcoriaceous); *three* series of gradate nervules in the anterior wings, of which the inner consists of eight nervules in the male and eleven in the female, the second of seven in the male and nine in the female, and the third (or outer) is continuous with the superior cubitus (in the male the sector and the inner series of gradate nervules are thickened); posterior wings with only two series of gradate nervules.

Length of body, ♂ 9 millim., ♀ 10 millim.; expanse, ♂ 21 millim., ♀ 25 millim. (*Blackburn*, one ♂, No. 20, one ♀, No. 21).

This is less complex in its neuration than *A. hepatica*, but the diversity in the form in the two sexes and the very singular condition of the costal margin in the male render it in some respects the more peculiar.

Chrysopa microphya, n. sp.

Body yellowish testaceous ("bright green" in life). Head polished; palpi, antennæ, and legs concolorous with the body;

basal joint of antennæ strongly bulbous; claws dilated internally at the base.

Abdomen apparently having a blackish band on either side, in which are yellow (or greenish) spots; clothed with rather long, but not dense, hairs. In the male it is terminated by a broad oval superior plate, concave beneath, and ventrally by a much shorter nearly semicircular plate.

Wings vitreous, slightly iridescent, ovate, subobtusate; venation strong, open; longitudinal nervures greenish, transverse and gradate nervules mostly blackish, the costal nervules pale at either end, the whole set with rather long black hairs; pterostigmatic region elongate (very long and somewhat dilated in posterior wings of male), greenish; subcosta becoming confluent with the costa before the apex; partition nervule of the third cubital cell extending beyond the nervule above it (the cellule oval); six and eight nervules in the two gradate series in the anterior wings of male, and four and five (or six) in those of the female (in the pair before me); fifteen to seventeen antepterostigmatic nervules.

Length of body 6 millim.; expanse, ♂ 20 millim., ♀ 22 millim.

One of the smallest species and, in some respects, aberrant, the condition of the subcosta showing analogy with *Hypochrysa*, and the formation of the apex of the abdomen with *Anomalochrysa*; but as there are only two series of gradate nervules it cannot be located in the latter genus.

"Not uncommon near Honolulu" (*Blackburn*, one ♂, one ♀, No. 22).

Chrysopa oceanica, Walker.

Chrysopa oceanica, Walker, Brit. Mus. Neuropt. p. 238.

In the British Museum, from Capt. Beechey; not sent home by Mr. Blackburn (*cf.* McLachl. Journ. Linn. Soc., Zoology, vol. ix. p. 268).

Myrmeleontidæ.

Formicaleo perjurus, Walker.

Myrmeleon perjurus, Walker, Brit. Mus. Neuropt. p. 340.

Myrmeleon violentus, Walker, l. c. p. 348, var.

In the British Museum, from Captain Beechey. "Occurs sparingly in a ravine rising very abruptly from the sea-coast near Uolulu, Maui" (*Blackburn*, No. 27).

Violentus is the form in which the dark streak in the apex of the posterior wings is absent. One of Mr. Black-

burn's examples shows no trace of this streak; in the other it is faintly indicated, but incomplete.

In the Journ. Linn. Soc., Zoology, vol. ix. p. 277, I united this with *F. striola* (Leach), Walker, a species occurring in Australia and also in several of the Pacific islands (and which in all probability is *F. bisignatus*, Rambur). Perhaps this connexion is just, but it is well to have further information.

Summary of Hawaiian Neuroptera.

PSEUDO-NEUROPTERA.

Termitidæ.

Calotermes castaneus, Burn. *Calotermes marginipennis*, Latr.

Embiidæ.

Oligotoma insularis, n. sp.

Psocidæ.

Psocus, sp. *Elipsocus vinosus*, n. sp.

Odonata.

<i>Pantala flavescens</i> , F.	<i>Agrion</i> (?) <i>hawaiiense</i> , n. sp.
<i>Tramea lacerata</i> , Hag.	— <i>pacificum</i> , n. sp.
<i>Leptemis Blackburni</i> , n. sp.	— <i>deceptor</i> , n. sp.
<i>Anax junius</i> , Drury.	— <i>callipha</i> , n. sp.
— <i>strenuus</i> , Hag.	<i>Megalagrion Blackburni</i> , n. sp.
<i>Agrion</i> (?) <i>xanthomelas</i> , Selys.	— <i>oceanicum</i> , n. sp.

PLANIPENNIA.

Hemerobiidæ.

Megalomus, sp.

Chrysopidæ.

<i>Anomalochrysa hepatica</i> , n. sp.	<i>Chrysopa micaphya</i> , n. sp.
— <i>rufescens</i> , n. sp.	— <i>occuica</i> , Walk.

Myrmeleontidæ.

Formicaleo perjurus, Walk.

Twenty-three species in all. No Trichoptera have been discovered, but it seems to me impossible to believe that none exist; nevertheless their number is probably limited; they should be sought for on the mountains where there is constant fresh water.

Meagre as the Neuropterous fauna of the islands apparently is, the materials are nevertheless instructive. Three

distinct faunistic factors seem to have played a part. The North-American element is represented by two, no doubt artificially introduced, species of white ants, and certain large dragon-flies, which having flown over at some time continue to breed. The Australian element is very small, and probably consists solely of the single ant-lion, which may be regarded as Polynesian. The strictly endemic element is the largest, and is represented by (*inter alia*) the Agrionidæ and the peculiar forms of Chrysopidæ, two groups of very different habits—the former necessitating a constant supply of fresh water with aquatic animal life for food, the latter a supply of small soft-bodied plant-frequenting insects on which their larvæ feed.

Such, then, is my opinion on the materials for the order of insects of which I have made a special study; but any broad generalization on the Insect-fauna must be left until the reports of other specialists on the results of Mr. Blackburn's investigations can be collated and correlated.

XXXIV.—*On the Answerable Divisions of the Brain in Vertebrates and Invertebrates.* By Prof. OWEN, C.B., F.R.S., &c.

THE principles or generalizations of homology and analogy force themselves on the attention of naturalists in many relations, and suggest questions on divers subjects. Take the heart of a Cephalopod, for example. Is it the homologue or the analogue of that of a fish? Is its relation thereto only that of identity of function, sometimes expressed by the term "homodynamous," which is synonymous with "analogous" in questions of this nature?

No naturalist, it may be presumed, doubts the homology as well as analogy or homodynamy of the heart of the cuttle-fish with the heart of the snail. If the latter were propounded as the subject of the inquiry, a biologist of eminence might pronounce that it was merely homodynamous with the heart of a fish, conceiving relations of position to be essential in determining the question of homology. Accepting the current views of such topical relations he might, probably would, reply, "The heart of the snail is on the back or 'dorsal' aspect of the body, while that of the fish is on the opposite or 'ventral' aspect."

Generalizing such particular questions and accepting the current replies, he would be justified in affirming that there was no homology between the vascular centres or systems of Vertebrates and Invertebrates.

The same conclusion, on the above assumption of their respective backs and bellies, affects another and, in this relation, more important organic system. Homology would be repudiated as between the myelencephalon of Vertebrates and the centres of the nervous system in Articulates. In the former the "brain," and, as in *Amphioxus*, a more constant part, viz. the "spinal marrow," are held to be on the "dorsal" aspect of the body; in Articulates the ganglionic chord, functioning as "spinal marrow," is held to be on the "ventral" aspect of the body. They may be, accordingly, "analogous" or "homodynamous," but are not answerable parts in the "homologous" sense.

An exception is indeed made by some zootomists in favour of one portion of the neural axis:—"The central nervous system of the Vertebrata is to be regarded as representing the superior or cerebral ganglia of Invertebrata"*,—that is, as being homologous with such ganglia and with their coalesced and developed condition in the Cephalopod; although, in fact, the part described as "brain" in such Invertebrate represents no more than the part of the brain in Vertebrates which is in connexion with the senses of sight and smell.

The ground, in short, on which such conclusions are based is simply that of the relative position to a part or aspect of the body as this may be carried by the animal during locomotion.

But before testing the value of such support of the conclusion, as it affects the question of homology, I may refer to the degree in which it checks or paralyzes another and higher biological line of thought. Gegenbaur, for example, finds it "quite impossible to derive the spinal chord from it"†, that is, to derive phylogenetically the continuous or more or less uniform myelon of Vertebrates from the ganglionic myelon of Arthropods and Annulates. I by no means think that a study of their developmental relations is to be abandoned in despair, the answerable aspects being rightly determined. But, before moving further on this line, I may remark that enlargements at the points where nerves communicate with

* Gegenbaur, 'Elements of Comparative Anatomy,' Ray Lankester's edition, 8vo, 1878, p. 501. Prof. Packard, more consistently, repudiates even this degree of homology (see his 'Second Report of the U.S. Entomological Commission,' 1880, p. 224).

† *Op. cit.* 15.

or pass from the Vertebrate myelon are many in some fishes (e. g. *Trigla*), and they are present, though in smaller number, in the short myelon of *Orthogoriscus**; and, further, that the researches of the microscopist and the experiments of the physiologist have led to the conclusion that the seemingly continuous and uninterrupted tracts of the spinal chord of Vertebrates are due to a coalescence through superadded or interposed neurine of as many ganglionic centres receptive of neural impressions, sensory or motory, which essentially are as distinct, or in as special topical relations to the nerves proceeding from or returning to such centres, as are the physically seemingly separate centres in the so-called "ventral ganglionic chords" of Invertebrates†.

To what indeed are the grounds of such above-cited judgments on the important homological questions at issue reduced when subjected to anatomical analysis?

One of the several ganglionic enlargements of the knotted chord and centre of the nervous system in Invertebrates is propounded as the homologue of the brain in Vertebrates; and I accept such homology, but only in the restricted sense or degree above noted. For I hold that the neural centres in relation to the sensations and motions of the tongue, jaws, and other parts of the mouth in Invertebrates, which centres are in direct communication through continuous "crura" or chords with the so-called "brain," are physiologically answerable to the parts of the brain with like nerves and functions in Vertebrates.

That there are parts of the Vertebrate myelencephalon which correspond with, are certainly analogous to, and, I believe, homologous with, such parts in Invertebrates, I have elsewhere endeavoured to demonstrate‡. The sole ground for rejecting such homology, or for its restriction to a part only of the brain of Invertebrates, is a different relation of the gullet to the prot- and metencephalous masses in Vertebrates and Invertebrates. The space dividing the fore brain ("protencephalon" of Vertebrates, "supercesophageal ganglion" of Invertebrates) from the hind brain ("epencephalon" of Vertebrates, "subcesophageal ganglion" of Invertebrates) is so reduced in Cephalopods, especially the Dibranchiates, that the recognition of their homology with the corresponding divisions of the brain in Vertebrates becomes obvious.

The intervening space is scarcely, if at all, less in the

* 'Anatomy of Vertebrates,' vol. i. 1866, p. 271.

† Newport, Phil. Trans. 1843, p. 243.

‡ 'Aspects of the Body in Vertebrates and Invertebrates,' 8vo, 1833.

brains of the lower Vertebrates. It needs only to refer to the comparative anatomy of the brains of fishes; and here I would refer to a late contribution thereto by the accomplished "Docent der Anatomie zu Berlin," the "Oberstabsarzt Dr. Rabi-Ruckard," entitled "Das Grosshirn der Knochenfische und seine Anhangsgebilde." A reference to the figures 1 and 2 of 'Taf. xii. of this memoir in the 'Archiv für Anatomie und Physiologie,' 1883, of a trout's brain (*Salmo fario*) suffices to show the homologous space under the name of "ventriculus tertius." It is one of the demonstrations of the foregoing homology. The amount of neurine in the lateral walls of this interspace due to the continuation of cerebral tracts homologous with those uniting the prot- and epencephalic divisions of the Cephalopodal brain, commonly termed "supra-" and "infra-oesophageal" ganglions, is somewhat greater in the fish, and the alimentary tract which in the Cephalopod traverses that interval, is represented in the Vertebrate by the modified remnant of the primitive gullet. This remnant extends upward (dorsad) beyond the fish's brain, penetrates the cartilaginous basis of the frontal bone, and is there arrested; in the opposite or "ventral" direction the "transcerebral tract" extends into the cartilaginous basis or floor of the cranium, which shuts off its original communication with the pharynx; the so-obstructed or closed parts of the transcerebral tract are converted into the parts called respectively the "pineal" and "pituitary glands," with the intervening "ventricle" and its "infundibular" prolongation.

Influenced by the foregoing facts, and reasonings thereupon, I deem the grounds for restricting the homologies of the nerve-centres of Vertebrates and Invertebrates to one portion only of the brain of the latter, known as the "supra-oesophageal ganglion," to be inadequate; and a sense of this inadequacy led me to institute the series of embryological and other researches on the conditions of the course of the gullet through the brain-centres of Invertebrates which were submitted to the Biological Section of the British Association at the Meeting held at York in 1881*. This communication was followed by the "Researches on the Homologies of the Neural Centres, their Parts and connected Nerves," submitted to the Linnean Society of London in 1882†.

The conclusions to which I was led enabled me, or seemed to me, to show that the position in which the body of an animal is carried in relation to the earth's surface is of less

* "Reports," &c. in 'Transactions of the British Association,' &c. for 1881. 8vo.

† 'Journal of the Linnean Society,' Zoology, vol. xvii. 1882.

value in determining the homology of its aspects than are the relative positions of the nervous and vascular centres to a given surface or aspect of the body. I concluded, therefore, that the "neural surface" of an Arthropod, indicated by the position and course of the main or central part of the nervous system, was homologous with the surface or aspect of the body so indicated in a Vertebrate; also that the condition which seemed to alter that relation in respect of a small part of the neural axis, in the Invertebrate, was inadequate to affect conclusions of homology based on the permanent relations to surfaces of the body shown by the nervous and vascular centres respectively, especially as such condition, affecting a small part of the Invertebrate nervous system, was discernible, though transitory, in the brain of the Vertebrate embryo.

Consequently I proposed to apply the term "neural" to the surface or aspect of the body which in progressive motion is carried upright and directed backward in man, and to apply the term "hæmal" to the surface or aspect of the body which is carried upright and turned forward in man; and I proposed to apply the same terms to signify homologous surfaces indicated by the positions of the nervous and vascular centres, which surfaces are horizontal and are carried respectively upwards and downwards in Vertebrates below mankind, but are carried downwards and upwards respectively in the Invertebrates above the "Radiaires" of Cuvier.

In higher members of this division (the starfish for example) the homologue of the "oesophageal ring" is the centre of the nervous system. As organization progresses the portion of the ring opposite to the part or aspect on which the mouth opens becomes the seat of developments in relation to the necessity of a provision receptive of impressions or influences affecting the more exposed and upturned surface of the body. Next follows the prolongation of the post-oral part of the frame, which may be segmented and cuirassed in some or be left soft and unjointed in others. But the primitive neural ring round the gullet remains in both the Annulate and Molluscous series. Such course of the gullet is finally checked at the higher Vertebrate stage by the development of a branchial chamber which takes in the materials for digestion as well as for respiration.

XXXV.—*Remarks on the Nyctisaura.*

By G. A. BOULENGER.

AMPHICELIAN vertebræ, distinct parietal bones, incomplete orbital ring, and absence of a parietal bar are the principal characters upon which the suborder *Nyctisaura* is based. Cope*, however, makes a restriction as to the former character, writing "vertebræ usually amphicoelian;" but in what forms the exception exists is not stated. So far as I know, procelian vertebræ occur in three genera only, viz. *Eublepharis*, *Psilodactylus*, and *Coleonyx*. No exception to the second character has been recorded; and I was not a little surprised to find that these very genera which so strikingly differed in the structure of their vertebræ, differed also from all other Geckos in having the parietal single, as in most *Cionocrania* proper.

Now that undoubted *Nyctisaura* are known to present exceptions to the two former characters, and as the absence of the orbital ring and temporal bar cannot be considered to distinguish them constantly from the *Cionocrania* (for the *Varanidæ* have the orbit incompletely surrounded, and the parietal bar is absent in the *Holodermatidæ*), there remains no character of sufficient importance to justify the suborder *Nyctisaura*; therefore I believe that it has to be cancelled. But I propose to maintain the old definition of the group as diagnostic of the family *Geckonidæ*, and to refer the three aberrant genera mentioned above to a distinct family, which I name *Eublepharidæ*. In spite of their extraordinary geographical distribution (*Eublepharis* is Indian, *Coleonyx* Central-American, and *Psilodactylus* West-African), these three genera are very closely allied, not only in structure, but even in coloration. They all possess connivent movable eyelids.

XXXVI.—*Contributions to our Knowledge of the Spongida.*

By H. J. CARTER, F.R.S. &c.

[Plates XI., XII., XIII., & XIV.]

MY "Contributions" in this respect may appear incoherent, but this will be understood by the statement that they are compiled from notes, sketches, and specimens put aside for

* Proc. Acad. Philad. 1864, p. 226.

more convenient opportunity of publication, from which the following species have been advisedly selected.

Order III. PSAMMONEMATA.

Family 1. BIBULIDA.

Char. "Solid fibre chiefly without core of foreign objects" ('Annals,' 1875, vol. xvi. p. 132).

Coscinoderma lanuginosum, n. gen. et sp.

Battledore-shaped, subsquare, compressed, stipitate, covered with a white, continuous cribriform incrustation of remarkable uniformity in its foramination. Surface for the most part even throughout, interrupted only by a small proliferous projection or outgrowth on one side and a line of vents situated pandean-pipe-like along the upper border, between which the structure is denticulated. Pores in plurality, situated in the sarcode tympanizing the interstices of the cribriform incrustation. Incrustation composed of microscopic foreign bodies, chiefly quartz-grains and fragments of sponge-spicules, imbedded in the anastomosing dermal fibre with such firmness, evenness, and regularity as to constitute a white, compact, reticulated, smooth, shagreen-like structure, whose interstices are uniformly subcircular and about the same size, viz. 1-90th inch in diameter, underneath which again the "subdermal cavities" make their appearance in much the same form, but twice the size and in the midst of fibre only. Fibre not less remarkable than the incrustation, for there appears to be almost an entire absence of the usual attenuation, the whole being almost uniformly alike in size and colour, viz. very small and fine, very long, scantily branched, curled up together in little whorls (representing so much wool under the same condition), of a deep sponge-colour, in the midst of which are excavated the channels of the pore and excretory systems, encircled respectively by the whorls of fibre, through which, in the absence of sarcode, their calibre is still maintained. When viewed under the microscope very few of the filaments are found to contain foreign bodies. Size of entire specimen 8 × 8 inches square by 1½ inch thick; stem 2 inches long, 1½ broad, and ½ thick, compressed, and terminated by a root-like expansion.

Hab. Marine.

Loc. Freemantle, S.W. Australia.

Obs. The remarkable appearance of the incrustation, internal structure, and characters of the fibre, if not the battledore-

shape of the specimen also, renders this species very easy of determination. There would be nothing extraordinary in the cribriform incrustation, as it is common among the *Bucellida* and *Hercinida*, were it not that it is so uniform in structure, smooth, and continuous, on account of the entire absence of any projection of the dermal fibre to render the surface polygonally divided, as in these families generally; but the wool-like character of the fibre, owing to its being so small and uniform in size, is peculiar. The specimen, which is very striking, is in the Bowerbank general collection at the British Museum.

Order V. ECHINONEMATA.

Family 1. ECTYONIDA.

Char. "Echinated with proper spicules on the fibre"
(*'Annals,'* l. c. p. 133).

Ectyon mauritanus, n. sp. (Pl. XII. fig. 3, a, b.)

Entire form not seen. General and microscopic characters the same as those of *Ectyon sparsus* (*'Annals,'* 1871, vol. vii. p. 270), with the exception of the spicule, which is nearly twice the size and still more beautifully ornamented, as may be seen by the illustration (Pl. XII. fig. 3, a), which is drawn upon the same scale as that of *E. sparsus* for comparison (*op. et loc. cit.* pl. xvii. fig. 3, a, b). It is about 52 by 4-6000ths inch in size, not including the projections of the spines laterally, each of which amounts to 1-6000th inch on each side, which gives a total diameter of 6-6000ths, for its greatest dimensions. The spines, instead of being circular and based on the surface of the spicule, as in *E. sparsus*, are compressed laterally and raised on an angular ridge or inflation, whereby the spicule presents a moniliform appearance, that is, a series of constrictions, which renders it so much more beautiful than that of *E. sparsus*, as before stated.

Hab. Marine.

Loc. Mauritius.

Obs. This specimen, with many others, was collected at the Mauritius by Col. Pike, then U.-S. Consul there, and forwarded to me by the late Dr. Dickie, F.R.S., in the month of November 1872*. It is not more than 2 inches in dia-

* I learnt from Mr. J. S. Tyerman in October 1881 that, when he was living at Liverpool, the collection was sent to him first, and that he sent it on to Dr. Dickie, the latter to Dr. Bowerbank, who, after a

meter, but is sufficiently large for me to see that, in general character, it is, as above stated, precisely like *Ectyon sparsus*. I have used a masculine termination for the specific name, in accordance with that adopted by Dr. Gray (Proc. Zool. Soc. Lond. 1867, p. 515), otherwise the termination "on" indicated neutrality; but as "*Ectyon*" appears to have no other meaning than that which Dr. Gray has assigned to it, and, like many other names applied to his genera of sponges, also appears to be nothing more than a "fortuitous combination of letters," as he himself states (*op. et loc. cit.* p. 500), I follow his example. Moreover, as there can be no doubt that the generic name was intended for Dr. Bowerbank's "West-Indian sponge" (Mon. Brit. Spong. vol. i. p. 275, pl. xvii. fig. 289), otherwise undescribed, I have used the term "*Ectyon sparsus*" (Nos. 462-3, being in halves) for that species in the British Museum which, if not identical with, is, at all events, most closely allied to it ('Annals,' l. c.); hence am carrying on Dr. Gray's appellation.

Ectyon flabelliformis, n. sp. (Pl. XI. fig. 1, 1 a.)

Flabelliform, pedunculate, composed of a large thin frond divided into three lobes, one central and two lateral, presenting concentric lines or ridges of growth on the surface; round undulating margin and short peduncular stem. Consistence tough, firm. Colour brown-yellow. Vents circular, large, numerous, and alone on one side, more or less irregular in form, and accompanied by smaller ones in groups, as in *Ectyon sparsus* (see Pl. XII. fig. 2, c), on the other, where the latter appear to be for the pores, and the most regular or circular ones only of the former for the vents, all sphinctrally tympanized by the dermal sarcode. Structure compact, clathrous throughout, the clathrous cavities extending to the surface, where they are also tympanized by the dermal sarcode, whose disappearance in the dried state causes some confusion as to function from their resemblance to the great irregularly circumscribed vents just mentioned (see Pl. XII. fig. 2, d).

Spicule of one form only, viz. acute, curved chiefly towards the large end, pointed at the other, bearing verticils of short spines throughout at nearly equal distances from each other; point smooth, large and spined (Pl. XI. fig. 1, a); average largest size of spicule about 30 by 3-6000ths inch in its

year, returned it, saying that he had not time to describe the specimens, and finally from Dr. Dickie to myself in July 1872. I have described several of them, but the rest are too fragmentary and rotten from the presence of sea-salt to be now worth any thing.

greatest dimensions; spicules forming the core of the fibre and echinating its surface in groups respectively, whereby the free surfaces are all hispid. Size of specimen 21×13 inches square in its greatest dimensions by about $\frac{1}{2}$ inch thick; stem well defined, peduncular, short, about $1\frac{1}{2}$ inch in diameter generally.

Hab. Marine.

Loc. West Indies.

Obs. This sponge has the appearance of a large piece of tanned cow-hide, and thus it may be easily recognized. The other characters, *mutatis mutandis*, are like those of *Ectyon sparsus*, and the spicule in its largest size, although a little thinner, is not inferior to that of *E. sparsus* in point of beauty. The specimen is in the British Museum, and bears my running number "367."

I am indebted to my kind friend Mr. Thos. H. Higgin, F.L.S., of Liverpool, for the illustration of this species (Pl. XI. fig. 1), which has been photographed from a much larger although similar specimen of the same species in the Liverpool Free Museum. It is 33 inches broad, 21 inches high, and averages (being irregular over both surfaces) about an inch in thickness; hence the real size is six times that of the illustration. It is registered "no. 4. 8. 81. 14," and was obtained from Barbadoes.

The cribriform grouping of the "small holes" on the surface over the subcavernous clathrous structure, which may be easily seen in the illustration of this and that of *Ectyon sparsus*, var. *claviformis* (Pl. XII. fig. 2, c), another specimen in the Liverpool Free Museum that will be mentioned presently, as well as in the original species, viz. *Ectyon sparsus*, which I described and illustrated in 1871 ('Annals,' l. c. pl. xvii. fig. 2), is also characteristic of the surface of the great Suberite from Belize, viz. *Spongia Dysoni* ('Annals,' 1882, vol. ix. p. 350). The photograph (Pl. XI.) represents the side on which the "small holes" exist.

General Observations on the Ectyones.

The specimen in the British Museum for which I have adopted the name "*Ectyon sparsus*" is solid, thick, flat, and expanded; but among others still larger, especially that registered 42. 12. 21. 40, there is one which consists of a group of eight thick erect hollow cylinders, mounted on a stand of "plaster of Paris," and numbered "548." Altogether the group is about 12×8 inches horizontally, of which the largest cylinder is 10 inches high, $3\frac{1}{2}$ inches thick, and $1\frac{1}{2}$ inch across at the

orifice. Here, of course, as in all *hollow* sponges, the vents open on the inner surface of the cylinder, and therefore few or none are on the outside, which thus contrasts strongly with that of the *solid* forms.

On the other hand there is a *solid* cylindrical form in the Liverpool Free Museum, of which Mr. T. Higgin has also caused a photograph to be made, and from which the illustration in Pl. XII. (fig. 2) has been lithographed. It is $16\frac{1}{2}$ inches high by $4\frac{1}{2}$ inches thick in its greatest dimensions, and therefore upwards of three times as large as the photograph, but clearly shows on the surface the scattered vents (fig. 2, *b*) and cribriform grouping of the "smaller holes" between them (fig. 2, *c*), to which I have already alluded, but which I have heretofore not had an opportunity of illustrating in an entire specimen of this species; hence am here again indebted to Mr. Thos. Higgin for his kind assistance *. Being club-shaped as well as cylindrical, I have, for distinction's sake, called this variety of *Ectyon sparsus* "*clavæformis*" (Pl. XII. fig. 2). Internally the colour is brown-yellow, but, probably from exposure on the beach where the specimen may have been picked up, the surface had become so bleached and white as to simulate a *vitreous* sponge; now, however, this has changed to dirty grey after exposure to a smoky atmosphere. It is registered 28. 3. 78. 5. As I have lately seen several examples of this form, but less club-shaped and more regularly cylindrical, I am inclined to think that it is the kind of growth most commonly assumed by the specimens of this species which come from the West Indies generally; while one cannot help being impressed with the fact that the spicules of all the forms from this district are so much alike that they alone present no specific difference.

For such sponges Dr. Bowerbank in 1866 (Mon. B. S. vol. ii. p. 14) instituted his genus "*Ophlitaspongia*," having first illustrated them in 1862 (Phil. Trans. pl. xxx. fig. 7). After this Duchassaing de Fonbressin and G. Michelotti described four species from the Caribbean Sea under the generic name "*Agelas*" ('Spongiaires de la Mer Caraïbe,' p. 76, 1864), apparently illustrating the two above mentioned, viz. *Ectyon sparsus* and *E. flabelliformis* (pl. xv. figs. 1 and 2, together with their characteristic spiculation in the diagram "G," pl. i.); but, as usual, there is too much room left for doubt in their descriptions to make them available. Subse-

* Mr. Higgin got these photographs made for illustrating a description of the Ectyonida which had been commenced by himself; but not knowing when he might have time to complete it, they were handed over to me for this purpose.

quently Dr. Gray divided Dr. Bowerbank's genus into the genera "*Seriatula*" and "*Ectyon*," allotting to the former our British species *Chalina seriata*, and to the latter Dr. Bowerbank's "West-Indian sponges," viz. *Ectyon sparsus* &c. (Proc. Zool. Soc. Lond. 1867, p. 515). Schmidt, in 1864 (Spong. adriat. Meeres, 1st Suppl. p. 35, Taf. iv. fig. 2), described and illustrated the European representative of *Ectyon* under the name of *Clathria oroides*, and in 1870 changed the name to "*Chalinopsis oroides*" for his West-Indian specimens (Spongienf. atlantisch. Gebietes, p. 60, Taf. v. fig. 2).

There is yet another species that has come under my observation, of which only a fragment about $2\frac{1}{2}$ inches long exists in the Bowerbank general collection at the British Museum, but sufficient for me to compile the following description under the name of

Ectyon cylindricus, n. sp. (Pl. XIII. fig. 4, a-e.)

Cylindrical, solid, curved (Pl. XIII. fig. 4, a, b). Consistence firm, resilient. Colour brown ochre-yellow. Surface even, reticulate. Vents scattered, numerous, large, round, averaging 1-8th inch in diameter (fig. 4, d). Cribriform groups of "small holes" not present here. Pores not seen. Internal structure firm, compact, tough, elastic, traversed freely by the branches of the excretory canal-systems, which open at the vents mentioned (fig. 4, b). Spicule acuate, curved, sharp-pointed, verticillately spined; average largest size 30 by $2\frac{1}{2}$ -6000ths inch in its greatest dimensions (fig. 4, c); verticils twenty-two in number, about 2-6000ths inch apart in the centre, diminishing in this respect towards the extremities, especially towards the point; spines about eight in the central verticils, becoming less in number towards the point, which is smooth for a short distance up; spicules forming the axis of the fibre and congregated into groups echinately on the outside, so that all the free surfaces of the cancellated cavities of the tissue and those of the excretory canals are thus rendered hispid. Size of fragment, which is cylindrical and represents a short segment only, of a large curve, about $2\frac{1}{2}$ inches long by 1 inch in diameter, slightly compressed, as may be seen by the section (fig. 4, b).

Hab. Marine.

Loc. West Indies.

Obs. This not only differs in general form from all the foregoing species, but also in structure, which is compact throughout, and not clathrous, while the only holes on the

surface are a few scattered large vents (fig. 4, *d*). The spicule, like that of *E. flabelliformis*, is a little thinner, but otherwise ranks next in beauty to that of *Ectyon sparsus*, presenting in like manner, from its hispid arrangement over the free surfaces, a beautiful object under the microscope by direct light, particularly characteristic of the echinonematous order to which it belongs. On the surface of this specimen also are scattered small isolated parasitic polyyps, about 1-24th inch in diameter (fig. 4, *e*).

Ectyonopsis ramosa, n. gen. et sp.
(Pl. XIII. fig. 5, *a*, *b*.)

Form:—a thick cluster of branches rising from a hard contracted peduncular base; branches compressed, dividing polychotomously, when, by lateral union, they may produce a clathrous lamina, or dividing dichotomously throughout, ending in bifid, thin, expanded extremities, or not dividing at all, and ending in a simple wedge-shaped or spatulous expansion, in the present instance $2\frac{1}{2}$ inches in its greatest width and 1-6th inch in thickness. Consistence firm, resilient, becoming hard, compact, and rigid towards the base. Colour now (in its dried state) sponge-brown. Surface even; fibre reticulate, with groups of echinating spicules springing from the lines of reticulation. No appearance of vents. Pores not seen, from absence of the dermal sarcode. Internal structure uniformly fibro-reticulate; solid, presenting no appearance of excretory canals; fibre echinated with the spicule of the species. Spicules of two forms, viz.:—1, acerate, cylindrical, slightly curved, obtusely ended, spined irregularly throughout, most thickly over the ends, which therefore look larger than the centre; about 48 by 4-6000ths inch in its greatest dimensions (fig. 5, *a*); 2, acuate, slightly curved, spined irregularly, chiefly over the large end, smooth and pointed at the other, about 53 by 4-6000ths inch in its greatest dimensions (fig. 5, *b*). Thus these two spicules are very much alike, and, on account of one end of the former often presenting a diminution in size, appear by gradations to run into each other; but while the former is chiefly confined to the axis, the pointed form in groups chiefly echinates the fibre. Size of specimen 7 inches high, 6 inches broad at the top, and $2\frac{1}{2}$ inches thick; stem, which is rather compressed, $1\frac{1}{2}$ inch in its greatest diameter.

Hab. Marine.

Loc. S. Australia.

Obs. This specimen, no doubt also picked off a beach, is very much worn in the outside branches, but the central ones

are tolerably perfect. Its dictyocylindrous form, generally compact solid structure, apparent want of vents and excretory canal-systems (probably from their smallness and contracted state in the dried specimen), are all indications of the order to which it belongs, while the spiculation in its character and arrangement so resembles that of *Ectyon* that, although generically different, as the name implies, there can be no hesitation in placing it among the Ectyonida, as the spines of the spicules are merely disposed irregularly instead of being confined to a verticillate arrangement. It bears the number 17. 2. 73. 6, and was presented to the Free Public Museum at Liverpool by Mr. C. P. Melly.

Family 2. AXINELLIDA.

Char. "Echinated with proper spicules projecting from the interior of the fibre" ('Annals,' l. c. p. 133).

Such is the simple diagnosis which I have given for this in contradistinction to that of the first family of this order, wherein the echinating spicule (generally claviform) has its base inserted in the surface instead of the interior of the fibre; but in all probability it will have to be considerably extended; for the group "*Multiformia*" (*op. et loc. cit.* p. 145), which, like that of "*Pluriformia*," in the first family of the Echinonemata, was only intended to include *provisionally* a number of distinct genera that I then had before me, but which I knew time and opportunity alone could, by description and illustration, make available for this purpose. It is this more extended sense which I now wish to initiate.

The term "*Axinellida*," which has been taken from that of "*Axinella*," used by Schmidt for a genus which he established in 1862 (*Spong. adriat. Meeres*, p. 60), was chiefly instituted by myself for sponges whose typical structure is perhaps best illustrated by that of *Halichondria ventilabrum*, Johnst., = *Phakellia ventilabrum*, Bk. (*Mon. B. S.* 1874, vol. iii. pl. xxii.), which is one of the "key" or typical specimens of the family "*Axinellida*" mentioned in my proposed classification of the Spongida (*op. et loc. cit.* p. 196); thus, if this sponge is divided with a sharp knife perpendicularly to the surface, the section will present the edge of a thin compact plane *mesially* (Pl. XIII. fig. 6, *a a*), from which on both sides, but especially externally, emanate *scopiform* portions (fig. 6, *b b b b*), which, curving upwards and outwards, become subdivided as they reach the surface, where their extremities are interunited by the dermal sarcode, which thus, tympanizing the spaces between them, keeps the whole together and affords a con-

venient structure for the situation of the pores. The spicules here are of two forms, viz.:—1, vermiculate, smooth, and cylindrical, sharp-pointed at both ends (Pl. XIV. fig. 9, *a*); and 2, acuate, smooth, curved or bent chiefly towards the blunt end (fig. 9, *b*); the former 73 to 130 by 1 to $1\frac{1}{2}$ -1800ths inch in its greatest dimensions, and the latter or acuate about 30 by 1-1800ths; thus the former are imperfectly represented in Dr. Bowerbank's illustrations (*op. et loc. cit.*), since the vermiculate spicules here, viz. "5" and "6," should have been sharp-pointed at each end, which would have been the case probably had they been boiled out of the microscopic fragment with nitric acid instead of mounted in the dried sarcode, where the draughtsman could not see that in the *perfect* form their ends were sharp-pointed*. The vermiculate spicules, which are by far the largest, form the base or axis of the "scopiform portions," and the acuates the echinating spicules, while both forms are indiscriminately mixed in the "median" plane. Such are the characters of the structure in *Phakellia ventilabrum*; but of course they may be more or less modified in other species of this family, since there may be only one form of spicule, viz. acuate, bent chiefly towards the thick end like the hilt of a pistol, which seems to be the most common situation of the curvature in the Echinonemata; or this "one form" may be acerate, or the skeletal spicule may be accompanied by flesh-spicules, as in the new species about to be described, viz. *Phakellia ramosa*; still the way in which the echinating character is produced is always the same as that mentioned in the diagnosis of the family. Sometimes there is a transitional form of the spicule in which the acerate appears to be thickened and shortened on one side, so as to produce a kind of subacuate form (Pl. XIV. fig. 14), which seems to explain how it is on the one hand that the spicule

* The quickest way to examine a sponge is to soak a microscopic fragment of it in distilled water for from twelve to twenty-four hours; then tear it to pieces on a slide, drain, dry, and mount with balsam as usual; but to be *certain* of the exact form of its spicules requires that they should be boiled out with nitric acid, which may also be easily and quickly effected by placing the microscopic fragment on the centre of a glass slide and covering it with a drop or two of nitric acid, then boiling this over a spirit-lamp with low flame till it is nearly dry, after which the same process must be repeated twice or thrice; and, finally, before the last drop of nitric acid is entirely dried up, removing the slide to the table, when, through gradually increased inclination and sufficient but careful edulcoration with distilled water, the residuum may be freed from all remaining acid, drained, dried, and mounted in balsam; or, if desired, another microscopic fragment, prepared as first mentioned, may be added to it previously, when the perfect form of the spicules respectively, together with their position *in situ*, may be seen at once in the same preparation.

when fully acuate often has its blunt end smaller in diameter than the shaft, and on the other that, in consequence of this half of the spicule having become thus thickened by shortening, the curve or bend comes to be on this side of the centre of the entire length.

Phakellia ramosa, n. sp. (Pl. XIV. fig. 10, *a-d*.)

Stipitate, expanded, branched stag-horn-like; branches compressed, terminating, after two or more divisions, in bifid, pointed extremities, varying in length and form in the same bifurcation, that is, from round or cylindrical and long to compressed and short. Stem hard and solid. Colour, now, in its dried state, light grey-brown. Surface even. Pores and vents not seen. Internally presenting in the vertical section a dense median plane, out of which, on both sides, extend upwards and outwards little scopiform portions or processes, which, in juxtaposition (like those to which I have alluded in *P. ventilabrum*), end on the surface. Spicules of three forms, viz.:—1, skeletal, acuate, smooth, sharp-pointed, curved towards the large end, which is smaller in diameter than the body of the shaft, about 50 by 2-1800ths inch in its greatest dimensions (fig. 10, *a*), more or less accompanied by an acerate about the same size or a little smaller (fig. 10, *b*); 2, flesh-spicule, acerate, minute, curved, smooth, sharp-pointed, in bundles or loose (?trichites), about 5-6000ths inch long, but very variable in size above this (fig. 10, *d*); 3, bihamate flesh-spicule, simple C- or S-shaped, 3-6000ths inch long (fig. 10, *c*); both in great abundance. The skeletal spicules, with their large ends fixed in the sarcode of the scopiform processes and their pointed ones projecting outside, give the echinated character (see Pl. XIII. fig. 6, *b b*), while the flesh-spicules are plentifully scattered among them. Size of specimen $4\frac{1}{2}$ inches high, $5\frac{1}{2}$ inches broad, and about 1 inch thick, being somewhat compressed; lamina of which the branches are formed about $\frac{1}{4}$ inch thick.

Hab. Marine.

Loc. Sydney, Australia.

Obs. This appears to be an intermediate form between the usually cylindrical-branched *Dictyocylindrus* of Bowerbank, and the flabellate form, viz. *Phakellia ventilabrum*, Bk. Hence the branches are, for the most part, compressed stag-horn-like, thinning out towards the extremities. The presence of the flesh-spicules also is a distinguishing character, while the scopiform processes emanating from both sides of a dense median or axial structure are remarkably characteristic

of the Axinellida. This specimen was presented to me in its dry state by my late friend, Dr. Dickie, F.R.S.

Phycopsis hirsuta, n. gen. et sp. (Pl. XIV. fig. 11.)

Stipitate, thickly and dichotomously branched, covered with a brown loose shaggy coat, looking altogether like a species of *Fucus*; branches round, exceedingly hard and rigid, diminishing in size dendritically, until they end in attenuated sharp points. Axial or condensed portion of the stem, which gives the rigidity, predominating over the hirsute appendages, especially towards the base, composed of colourless fibre charged with the spicules of the species, and so hard and tough as to resemble the dried stalk of a stipitate *Laminaria* or *Keratophyte*; hence preeminently illustrating this character in the *Echinonemata*. Shaggy or hirsute coat composed of minute sarcodic filaments about half as long as the diameter of the condensed or axial portion, emanating in a round form from the circumference of the latter and equally charged with spicules of the species, curving upwards and outwards, and becoming more or less spatular as they approach their termination, which is sometimes slightly bifid; echinated as usual throughout by the projecting ends of the internal spicules. Spicule of one form only, viz. acerate, curved, smooth, sharp-pointed at each end, 29 by $\frac{3}{4}$ -1800ths inch in its greatest dimensions (fig. 11). Size of specimen about 4 inches broad by 4 inches high, and, being compressed, about 1 inch thick; stem $\frac{3}{4}$ -12ths inch in diameter at the base.

Hab. Marine.

Loc. South Australia.

Obs. The characters of this specimen as above given are sufficient to distinguish the species, which, at first sight, looks so much like a specimen of hirsute sea-weed that microscopic examination is necessary to prove that it is a sponge. It was sent to me by the late Dr. Dickie, F.R.S.

So far as my observation goes there is not another sponge of this order with such a dense, large, wood-like stem. Undoubtedly it is closely allied in most respects to the British species of "*Dictyocylinndrus*, Bk.," but, unlike these species, it has only one form of spicule, and that an acerate; while all the British species of *Dictyocylinndrus* possess an acuate skeleton-spicule and a short, clavate, spined echinating one, which places them in the first family of this order. There is a similar specimen in the British Museum which also came from "Australia," viz. No. 621, registered 72. 11. 6. 1. Probably the characteristic stiffness or rigidity of all the species of *Dictyocylinndrus*, especially that of the stem, is owing to the strong, glue-like, tenacious nature of the sarcode.

In the British Museum there is yet another species of this kind, which also came from the same neighbourhood, viz. "Van Diemen's Land" (No. 397), labelled in Dr. Gray's handwriting, "517, *Radiella*;" but it is not mentioned in any of his publications, so that it appears never to have gone beyond the MS. form mentioned; whereas Schmidt, in 1870 (*Spongienf. atlantisch. Gebietes*, p. 48), published a genus by this name, under which two species are described (Taf. iv. figs. 6 & 8), viz. *Radiella sol* and *R. spinularia*, the latter identified by Schmidt himself with Dr. Bowerbank's *Tethya spinularia* (Mon. B. S. vol. iii. pl. xv. figs. 23-30); while both species appear to me to belong to Dr. Bowerbank's genus "*Polymastia*," established in 1866 (*op. cit.* vol. ii. p. 5). As the term "*Radiella*," therefore, is only in MS., Schmidt's use of it in *print* must be preferred, and a new one instituted for the specimen in the British Museum, which, being totally different from Schmidt's *Radiella*, while it is closely allied to *Phycopsis hirsuta*, I will describe under this generic name as follows:—

Phycopsis fruticulosa, n. sp. (Pl. XIV. fig. 12.)

Stipitate, bushy, thickly and dichotomously branched from a common stem; clothed with bright brown filamentous processes. Branches thick, round, dividing at short intervals so as to form a close shrubby mass; diminishing in diameter from the stem upwards, ending in thick round points. Axial portion or stem not predominating, being only one sixth of the length of the filamentous processes in diameter, composed of colourless fibre charged with the spicules of the species. Filamentous coat consisting of narrow strips of yellowish sarcode, about half an inch in length, also charged with the spicules of the species, emanating from the circumference of the axial portion in a radiating manner (hence, probably, Dr. Gray's MS. name "*Radiella*") upwards and outwards, more or less united together at first, but finally terminating by division into two or more white or colourless threads, which give the surface a filamentous aspect; echinated throughout by the projection of the spicules. Filamentous coat longest midway between the base of the stem and its branched extremities; shortest about the base, where the stem is thick and hard, as in the foregoing species. Spicule of one form only, viz. acerate, curved, smooth, and sharp-pointed at each end, like that of the last species, about 35 by $1\frac{1}{2}$ -1800ths inch in its greatest dimensions (fig. 12). Size of specimen $3\frac{1}{2}$ inches high by $2\frac{1}{2}$ in its greatest horizontal diameter.

Hab. Marine.

Loc. Van Diemen's Land.

Obs. Although this sponge, from its general appearance and spiculation, is closely allied to *Phycopsis hirsuta*, yet the form and greater length of the hirsute filaments, together with the less compact and generally much smaller axis, at least claim the separation above indicated. Like *Phycopsis hirsuta* it is closely allied to the genus *Dictyocylindrus*, Bk., but, for the same reason as that above assigned, it is placed among the Axinellida. The hirsute appendages are, of course, equivalent to the scopiform processes in *Phakellia ventilabrum* &c.

We next come to two species of much more modified forms, although still fundamentally possessing the same kind of structure, and therefore giving rise to allied development. There are the same kind of echinated scopiform processes emanating from the same kind of condensed axial stem as in the other Axinellida, but the general form consists of long narrow branches which altogether present a feather-like group; hence the genus will be termed "*Ptilocaulis*," with the following species:—

Ptilocaulis gracilis, n. gen. et sp.
(Pl. XIII. fig. 8, and Pl. XIV. fig. 13.)

Long, cylindrical, plumose branches, dichotomously and polychotomously divided, rising from a hard contracted solid base. Branches about half an inch in transverse diameter generally; obtusely ended (Pl. XIII. fig. 8). Colour now, that is in the dried state, white, transparent. Axis consisting of slightly condensed fibre charged with the spicules of the species, from which emanate processes of the same structure in a floral form like the leaves of a Corinthian capital (fig. 8); passing through a delicate reticular tissue at the base and becoming inflated, clavate, bifid, or irregularly divided at the extremities. Spicules of one form only, viz. acute, curved chiefly towards the large end, smooth, sharp-pointed, about 17 by $\frac{1}{2}$ -1800th inch in its greatest dimensions (Pl. XIV. fig. 13); more or less obscured in their echination, by being covered with an extension of the outer layer of the transparent fibre. Size of specimen, which consists of several branches in a group, 18 inches long by $9\frac{1}{2}$ inches in its greatest horizontal diameter.

Hab. Marine.

Loc. West Indies.

Obs. This graceful specimen, looking in its dried state like a cluster of long, drooping, narrow, round feathers, affords

another instance of the characteristic features of the Axinellida, in the condensed structure of the axis growing outwards into spatuliform or clavate processes (equivalent to the scopiform ones of *Phakellia ventilabrum*), and the acute spicule, curved chiefly towards the large end, the echination being somewhat concealed, as above stated, by an extension of the outer lamina of the transparent horny fibre over their points, which thus encloses them. It is in the British Museum, No. 483, registered 45. 12. 30. 1, and has very much the appearance, under a different form, of "*Spongia Marquezii*," De Fonbressin et Michelotti (Spong. de la Mer Caraïbe, p. 40, pl. xx. fig. 1, Harlem, 1864), which, together with the diagram of its spiculation, given in pl. ii. "A," seems to confirm this view, although de F. et M.'s descriptions in other respects defy all attempts at further identification.

Ptilocaulis rigidus, n. sp.

(Pl. XIII. fig. 7, and Pl. XIV. fig. 14.)

Stipitate, composed of long, rough, cylindrical branches dichotomously divided, rising from a short hard stem; branches narrow, round, about an inch in transverse diameter, obtusely ended (Pl. XIII. fig. 7, *a, b b*). Colour now, in its dried state, brown. Axis consisting of condensed fibre charged with the spicules of the species, from which emanate in equally condensed structure thick short processes that give it its rough appearance, viz. spatuliform and expanded, bifid or irregularly divided towards the circumference, more or less irregular in form generally, lobate, sometimes interuniting clathrously and situated at variable distances from each other; pubescent generally, from the well-marked projection of echinating spicules, that is the echinonematous character (fig. 7, *b b*). Spicule of one form only, viz. acerate, smooth, curved or rather bent on one side of the centre, sharp-pointed especially at one end, which is more attenuated than the other, therefore partaking of the form of an acute or subacute form; 33 by $1\frac{1}{2}$ -1800ths inch in its greatest dimensions (Pl. XIV. fig. 14). Size of specimen 2 feet long by 11 × 2 inches in its greatest horizontal dimensions, presenting a compressed cluster of long cylindrical branches.

Hab. Marine.

Loc. ? Australia.

Obs. This specimen is very much like the last in general appearance, but probably came from the coast of South Australia, judging from its more robust form and greater rigidity. Like the other specimens from Australia before described, viz. *L'hyecopsis*, it has but one form of spicule, and that acerate;

also like these, it has all the characters, except in spiculation, of Dr. Bowerbank's British species of "*Dictyocylindrus*," modified. Sharp-pointed as the spicule is at both ends, the preponderance being on one side of the centre causes it to tend towards the acute form, which is characteristic of the last species. There are two specimens of this sponge in the British Museum, which are both numbered "402," but without register-number.

Different again as the foregoing specimens may be from those with which we commenced this family, the following are so much more so in appearance that, until minutely examined also, the fundamental composition and structure which determine their position cannot be satisfactorily observed. At first they look so much like specimens of *Halichondria panicea* that it is difficult to conceive that they do not belong to the same group or genus (which is the first in my order Holorhaphidota) on account of the massiveness of their structure, the characteristic whiteness of the dermal layer and the sponge-colour of the interior also being so similar; but the delusion disappears as the structure and spiculation of the elementary portions of a typical species like the following are microscopically examined, when the "scopiform" filaments emanating from the condensed axial structure recall to mind those of *Phycopsis fruticulosa*, and there is also an echinating spicule, which here (although not in all the species belonging to this group) is *acute* and not *acerate*; still, as this is chiefly seen in the circumferential growths before they pass into the axial or general mass, it is necessary especially here to look for it at the commencing rather than in the subsequent development, wherein all such distinctions become merged in the general mass.

Leucophlæus massalis, n. gen. et sp.
(Pl. XIV. fig. 15, a, b.)

Globo-conical, massive, surrounded towards the base with proliferous, erect, conical columns of variable size and length, entering as they grow into the increase of the central part. Consistence compact. Colour snow-white. Surface smooth, but irregular, being more or less rugose and furrowed vertically, pierced with minute puncta which now (in the dry state) indicate the position of the pores. Vents not seen. Internal structure concealed by a thick white crust, composed of the spicules of the species supported on a dense sponge-brown fibrous mass, partaking in compactness of the axial structure of the circumferential columns, which in their turn

consist respectively of a small solid axis, around which radiate in all directions, upwards and outwards, filamentous scopiform portions echinated by the projection of the internal spicules which, finally dividing, end in a lash of branches, and these, united together by the dermal sarcode, support the white incrustation of proper spicules on the surface. Spicule of one form only, viz. acuate, smooth, curved chiefly towards the blunt end, sharp-pointed, less in diameter at the obtuse end than in the centre of the shaft, 35 by 1-1800th inch in its greatest dimensions (Pl. XIV. fig. 15, *a*); abundant in the general mass and axial parts of the scopiform, filamentous processes, from which the points more or less project in an echinating manner. Size of specimen 6 by 3½ inches at the base and 4 inches high.

Hab. Marine.

Loc. Freemantle, S.W. coast of Australia.

Obs. The thickness of the white dermal layer and the compact solid structure of the interior, together with the mode of growth in each, combined with an acuate spicule chiefly curved towards the large end, distinguish this sponge from *Halichondria panicea*, which otherwise it so resembles, that to all appearance at first sight, as above stated, the two are the same. The specimen may be found in the Bowerbank general collection at the British Museum.

My attention was originally called to this species by the still greater likeness to *Halichondria panicea* of a similar specimen in the general collection of the British Museum, wherein the structure is not so evident as in the specimen above described, owing to the proliferous columnar processes of the circumference being less distinct and more involved in the general mass, which is globular and large, *v. e.* 6 × 6 inches in its greatest horizontal diameter and 3½ inches high; the form of the spicule is the same, but it is much larger, viz. 50 by 1½-1800ths inch in its greatest dimensions (Pl. XIV. fig. 15, *b*). It came from New Zealand, was presented by Dr. Sinclair, and bears my running no. "473," with the registration "57. 1. 2. 29."

Leucophlæus compressus, n. sp. (Pl. XIV. fig. 16, *a*.)

Stipitate, hard, massive, compressed, lobate, proliferous; lobes flabellate, more or less denticulate at the margin, sometimes united clathrously; stem thick, short, hard, expanded at the base of attachment. Colour snow-white. Surface uniformly even, consisting of a white crust composed of the spicules of the species; granulate, continuous, or reticulate according to the amount of incrusting material; sometimes

raised in vertical ridges over the stem, which extend radiatingly more or less to the circumference. Vents scattered over the surface as simple holes, which may be margined or stelliform. Whiteness of the incrustation, which extends sufficiently deep to include the marginal cavities, followed by a light brown colour of the fibre which, charged with the spicules, of the species, increases in density of structure towards the axis or centre. Spicule of one form only, viz. acerate, curved, fusiform, smooth, sharp-pointed, varying in size from 11-30 by $1\frac{1}{3}$ -1800ths inch in its greatest dimensions (Pl. XIV. fig. 16, *a*), the smaller, mixed with the longer ones, echinating the surface. Size of specimen 10 inches high, 11 inches broad, and 28 inches round its greatest horizontal diameter.

Hab. Marine.

Loc. Swan River, W. Australia.

Obs. There are at least four specimens of this species in the general collection of the British Museum, viz. :—no. 592, registered 72. 5. 21. 41, which is that above described; no. 534, registered 59. 10. 7. 24, both from Australia; and nos. 197 and 506, bearing the nos. of the dealer only, viz. "42 *a*" and "42 *b*" respectively. No. 20, registered 71. 5. 12. 1, from Port Elizabeth, S. Africa, appears to be of the same kind; but this possesses an acuate spicule together with a small acerate. Nos. 534 and 20 present the radiating lines mentioned with the same kind of acerate spicule (Pl. XIV. fig. 16, *b*), but no conspicuous vents; while nos. 592 and 506 do present vents; still, as I have above stated, all appear to belong to the same category.

To this group I think we may relegate Dr. Bowerbank's genus "*Ciocalypta*," established in 1866 (Mon. B. S. vol. ii. p. 5), of which he has described and illustrated three species, viz. *Ciocalypta penicillus*, *C. Leei*, and *C. Tyleri*; the first two are British, and the last species, of which there is also a specimen in the British Museum (no. 24, reg. no. 71. 5. 12. 1), comes from Algoa Bay, at the Cape of Good Hope. They are all composed of what Dr. Bowerbank has called the "penicillate organ," that is our "proliferous, erect, conical column," grouped together in greater or less plurality. (See representation of *C. penicillus*, Mon. B. S. vol. iii. pl. xiii. fig. 2; and of *C. Tyleri*, Proc. Zool. Soc. Lond. 1873, pl. iv. fig. 9.) *C. Leei*, however, of which a single "penicillate organ" only is represented in Dr. Bowerbank's illustrations of this species (*op. cit.* vol. iii. pl. lxxxvi. fig. 1), exists in great plurality on one specimen in the Kent collection, from the coast of Portugal, in the British Museum (no. 7), if I am right in identifying the two, which I see no reason to doubt, although the

latter presents a granulated surface, which the former in the illustrations does not. Fig. 2 (Bk. l. c.) also, which is intended to represent the dermal expansion (in short, the "incrustation") of one of the bundles of spicules (that is, the "scopiform process" emanating from the axial structure) after having passed through the subdermal cavities, *hardly*, in its circumscribed umbrella-like form, realizes the interunion of such expansions to form the dermal crust, as might be anticipated, nor is it indicated by Dr. Bowerbank's description (*op. et l. c.* p. 297). In Saville Kent's specimen, the "penicillate organ" is much larger and longer, while the granulated surface, when viewed from the interior, may be observed to be formed by the apex of the "umbrella"-like expansions as they interunite at the circumference to form the white crust. The illustration of *C. penicillus* (*op. et l. c.*) closely resembles in figure that of *Leucophlæus massalis*, only the latter is more compact towards the centre, but the form of the spicule is the same, viz. *acuate*. while the two other species of *Ciocalyptra* present *acerate* spicules; still, in each, there is *only one form* of spicule, faced by an intermingling of a small one of the same form, which thus thickens and increases the whiteness of the dermal layer.

Order VI. **HOLORHAPHIDOTA.**

Family 1. **RENIERIDA.**

Char. "Spicules more or less arranged in a fibrous form. Structure yielding to pressure like crumb of bread" ('Annals,' l. c. p. 133).

New group. **Phlæodictyina.**

(See char. 'Annals,' 1882, vol. x. p. 117.)

Phlæodictyon singaporense, n. sp.
(Pl. XIII. fig. 17, a, b.)

This specimen, now incomplete, seems when entire to have been globular, but having been cut off horizontally from the base, presents a convex or subhemispherical form, from the surface of which several blind, hollow, tubular appendages are prolonged. Consistence fragile. Colour said to be "bright yellow" when fresh, but now, in its dried state, brown. Surface uniformly even, except where interrupted by the tubular prolongations. Pores and vents not seen. Tubular appendages hollow, ten in number, of which five only remain entire, two of which are bifurcated; one appendage, of

rest, *i. e.* 1-3rd inch in diameter, while the five entire ones, about an inch long respectively, of which two, as before stated, are bifurcate, are all closed and round at the extremities. Internal structure consisting of an open reticulated, coarse, white spicule-fibre (that is, composed of spicules only held together by a minimum of sarcode, or holorhaphidotic), which fills the cavity of the body and in the horizontal section at the base presents a subconcentric growth, covered on the surface by a thin, soft, dermal layer of small spicules. Body-structure permeated vertically by tubular channels, which respectively communicate with the tubular appendages of the surface, which on their part are formed by hollow extensions of the coarse reticulated structure of the body covered by that of the soft brown dermal layer before mentioned, which also extends more or less into the *interior* of the reticulated structure generally. Spicules of two forms, viz.:—1, large, skeletal, acerate, fusiform, curved, smooth, more or less abruptly sharp-pointed and often blunt, about 72 by 4-6000ths inch in its greatest dimensions (Pl. XIII. fig. 17, *a*); 2, smaller spicule, cylindrical, smooth, much curved, obtuse and rounded at each end, sausage-like, varying in size from 10 to 20 by 1-6000th inch (fig. 17, *b*). Skeleton-spicules chiefly confined to the now white body-fibre, and the smaller ones to the now brown dermal layer. Size of specimen, in its present hemispherical truncated form, about 1 inch high by 2 and $1\frac{1}{2}$ inch respectively in diameter across the truncated surface or present base, thus irregularly oval.

Hab. Marine.

Loc. Singapore.

Obs. The bright colour when fresh and the spiculation are the distinguishing characters of this species. Although the excretory canals in the body-structure can be seen to be in continuation, as above stated, with the tubular appendages, yet there is, as in other species of the group, no appearance upon the latter or the body generally of vents; but their being in continuation with the tubular appendages indicates that the whole belong to the excretory canal-system, and the open structure observed at the extremity of the appendages themselves in *Oceanapia* ('Annals,' 1882, vol. x. p. 119) seems to confirm this view, by supplying the place of a distinct vent or vents of the usual form.

There is a similar specimen in the Johnstonian collection in the British Museum, now bearing my running no. "54," but no register no. and no locality. That belonging to the Liverpool Free Museum is numbered 24. 5. 83. 21, and was, together with another specimen of about the same size, but still more incomplete, presented by Dr. Archer.

Observations on Classification.

Now although the terms of my classification ('Annals,' 1875, vol. xvi. p. 126 *et seq.*) may be very plain to myself, who have carefully examined each of the specimens in the British Museum, including those lately purchased from Dr. Bowerbank's executors, in all amounting in cubic measurement to three or four yards, or sufficient to fill a small room of this size—consisting of thousands of specimens from various parts of the world, most of which are still undescribed,—yet these terms may not be so plain to those whose observation in this respect has been confined to their own cabinets, which can hardly be expected to afford so much *general* knowledge; therefore, before any determined opposition is made to my classification I trust it may be based on a similar amount of practical experience, when such criticism ought to be very valuable; for I do not wish to insist on my views any further than as the best *under the circumstances* that I could offer, therefore still open to great improvement. When the Spongiida shall have been worked upon as much as the Plants, then their classification may be expected to be as satisfactory.

EXPLANATION OF THE PLATES.

N.B.—The spiculation of the *Ectyones*, together with that of *Ectyonopsis*, is all on the same scale, viz. 1-12th to 1-6000th inch, chiefly to show their sizes *relatively*. That in Pl. XIV. is all on one scale also, viz. 1-12th to 1-1800th inch, for the same purpose; with the exception, however, of the flesh-spicules *c* and *d*, fig. 10, which are on the scale of 1-12th to 1-6000th, and the spicules &c. of the Diluvium from the valley of the Altmühl river, in Bavaria, whose scales respectively are stated *in loco*.

PLATE XI.

- Fig. 1. *Ectyon flabelliformis*, n. sp. One sixth of the natural size. From a photograph. Specimen in the Liverpool Free Public Museum. *a*, spicule. West Indies.

PLATE XII.

- Fig. 2. *Ectyon sparsus*, var. *claviformis*, n. var. Less than one third of the natural size. From a photograph. Specimen in the Liverpool Free Public Museum. *a*, spicule; *b*, vents; *c*, small congregated foramina; *d*, clathrous openings. West Indies.
- Fig. 3. *Ectyon mauritianus*, n. sp. *a*, spicule, lateral view; *b*, transverse section. Mauritius.

PLATE XIII.

- Fig. 4. *Ectyon cylindricus*, n. sp. (fragment), nat. size. *a*, lateral view; *b*, transverse section; *c*, spicule; *d*, vents; *e*, parasitic polyp. West Indies.

Mr. H. J. Carter on *Spicules of Spongilla*.

- Fig. 5. *Ectyonopsis ramosa*, n. sp., spiculation of: *a*, axial form; *b*, echinating form. W. coast of Australia.
 Fig. 6. *Phakellia ventilabrum*, Bk., diagram of skeletal or spicular structure: *aa*, mesial plane; *bbb*, scopiform processes. Shetland.
 Fig. 7. *Psilocaulis rigidus*, n. sp., fragment magnified two diameters, to show scopiform processes: *a*, stem; *bbb*, processes. ? S. Australia.
 Fig. 8. *Psilocaulis gracilis*, n. sp., terminal end of a branch, nat. size. West Indies.
 Fig. 17. *Phleodictyon singaporense*, n. sp., spiculation of: *a*, skeletal spicule of fibre; *b*, smaller spicule of dermal layer. Singapore.

PLATE XIV.

- Fig. 9. *Phakellia ventilabrum*, Bk., spiculation of: *a*, vermicular form; *b*, acute.
 Fig. 10. *Phakellia ramosa*, n. sp., spiculation of: *a*, acute; *b*, acerate; *c*, bihamate; *d*, trichites.
 Fig. 11. *Phycopsis hirsuta*, n. sp., spiculation of. One form only, viz. acerate.
 Fig. 12. *Phycopsis fruticulosa*, n. sp., spiculation of. One form only, viz. acerate.
 Fig. 13. *Psilocaulis gracilis*, n. sp., spiculation of. One form only, viz. acute.
 Fig. 14. *Psilocaulis rigidus*, n. sp., spiculation of. One form only, viz. acerate or subacute.
 Fig. 15. *Leucophloeus massalis*, n. gen. et sp., spiculation of two specimens, viz.:—*a*, acute of Dr. Bowerbank's specimen; *b*, acute of specimen in the British-Museum general collection.
 Fig. 16. *Leucophloeus compressus*, n. sp., spiculation of two specimens, viz.:—*a*, acerate of specimen described; *b*, acerate of no. 534.

XXXVII.—*Spicules of Spongilla in the Diluvium of the Altmühl Valley, Bavaria.* By H. J. CARTER, F.R.S. &c.

[Plate XIV.]

So far back as the 3rd March, 1881, Professor Zittel, of Munich, kindly sent me some pieces of dark brown argillaceous diluvium from the valley of the Altmühl, in which he had recognized spicules of a *Spongilla* (Pl. XIV. fig. 18, *a*, *b*); but, partly from want of opportunity and partly from want of the necessary knowledge, I have not been able to record publicly the results of my examination of it until the present time.

This freshwater deposit, besides the skeletal spicules mentioned (fig. 18, *a*, *b*), which, from their spiniferous character, appear to me to be most nearly allied to those of *Spongilla* (*Meyenia*, Crtr.) *erinaceus*, Ehr., contains another kind which are quite new to me (fig. 18, *c-f*), together with the detritus of

Diatomaceæ in great abundance, the pollen-grains of a Conifer (fig. 18, *k*), the (?) spore-cases of ferns, and the tetraspores of an acotyledonous plant (fig. 18, *l*), all of which are so recent as to be unfossilized.

When a fragment of this diluvium is broken to pieces in water, it soon falls into powder, and then the whole of these contents may be examined under the microscope in their present state; or it may be boiled in nitric acid, when the carbonaceous elements for the most part disappear, and the *siliceous* ones *alone* remain.

In the latter state the spicules of the *Spongilla*, from their larger size and great abundance, become the most prominent objects, while from their intensely spinous character (fig. 18, *g*) they appear, as before stated, to be most nearly allied to the skeletal ones of *Spongilla* (*Meyenia*) *erinaceus*, which was first found in the river Spree, and described by Ehrenberg under this name in 1846 (Monatsberichte der Berliner Akad. d. Wissensch. pp. 96-101, ap. Vojdovski). Here, *i. e.* in this diluvium, they vary in length between 17 and 59-6000ths inch, while the spines are proportionally much longer and larger in the short than in the long forms; all these spicules are acerate, fusiform, and gradually acuminate at the ends; but the longest only present the usual curve, with a breadth in the centre of 3-6000ths inch, exclusive of the spines (fig. 18, *a, b, g*). With them there are also a few others that are quite smooth, fusiform, and also curved, but abruptly pointed at the extremities, therefore probably belonging to another species. Again, in two instances I have met with a slender birotulate presenting a smooth and slightly curved shaft, altogether about 7-6000ths inch long (fig. 18, *h, i*); but in no instance have I observed any other form of statoblast-spicule, although one might have expected, from the minuteness of this delicate specimen, to have at least found some of the birotulates of *Spongilla erinaceus*, if the skeletal spicules just described had belonged to this species. With the exception of some pyxidial frustules among the immense quantity of detritus of Diatomaceæ present, which, if not carefully examined, might be mistaken for such statoblast-spicules, I have not found the least trace of any thing like a birotulate of *S. erinaceus*, while the slender birotulate to which I have alluded only finds its like in the much stouter statoblast-spicule of *Meyenia Baileyi*, Bk., and other species of the kind in North America, viz. in the State of Pennsylvania, whence my kind friend Mr. Ed. Potts, of Philadelphia, has sent me specimens of species which he has discovered there, and is now embodying in a Monograph

of the Spongillidæ of North America; unless it came from a statoblast like that represented by Dr. W. Dybowski ("Die Süßwasserschwämme des russischen Reiches," Mém. Acad. St. Pétersbourg, tome xxx. no. 10, 1882, pl. i. fig. 4, a).

With reference to the supposed identity of the spiniferous spicules in the diluvium of the valley of the Altmühl river with those of *S. erinaceus*, I would observe that having, through the kindness of Dr. Franz Vejdoski, of Prague, received on the 21st June last a copy of his valuable paper on the freshwater sponges of Bohemia ("Die Süßwasserschwämme Böhmens," 1883), in which he has described and illustrated *Spongilla erinaceus*, Ehr., under the "subgeneric" name "*Trochospongilla*" (*op. cit.* p. 31, Separat-Abdruck), from specimens found at Celakowic and Podiebrad, on the Elbe, respectively about 13 and 26 miles E.N.E. of Prague, I wrote to him for a microscopic portion to examine, which he very kindly sent me on the 17th July following.

I then saw in reality what I had previously only seen in print, viz. that strongly developed spiniferous character of the skeletal spicules which seems to have led to the specific term "*erinaceus*," first used by Ehrenberg as above stated; but still the spiniferous character generally, even here, was not nearly so much developed as in the smaller spicules of the Altmühl diluvium, although the dimensions and *spination* too of the *largest* spicules were much the same. What, however, most struck me was the identity in form of the birotulates of *Spongilla erinaceus* with those of the American species *S. (Meyenia) Leidyi*, Bk., so that I began to think that they must be the same species; however, I find that the skeletal spicules of *Meyenia Leidyi* in the specimen described by Dr. Bowerbank and those lately sent me by Mr. Potts are smooth, almost cylindrical, and abruptly pointed, averaging in their largest size not more than half the length of those of *S. erinaceus* from the Elbe, which, on the other hand, are fusiform and gradually pointed; thus a difference in this respect seemed to me to be evident; but on going further and comparing the skeletal spicules of *S. erinaceus* with those in the *first* fragment sent me by Mr. Potts, viz. that mounted on a slide from the Schuylkill river, I find the two almost identical. Now as the original specimen named by Dr. Bowerbank, which Prof. Leidy sent to him in 1863, came from the same river, it follows that the difference in the skeletal spicules to which I have just alluded goes for nothing, and therefore that the European and American species must be considered identical; while the stelliform branched excretory canal-systems on the surface of the *entire* specimens latterly

sent me by Mr. Potts, to which I have alluded, also characterize the *entire* specimens from the Elbe (see Dr. Vejdovski's representations of the latter, *op. cit.* pl. iii. fig. 14, A, B, &c.), which seems to confirm this view still further.

It is remarkable that, in addition to the well-known species of the Old World, viz. *Spongilla lacustris* and *Meyenia fluviatilis*, two other *distinct* ones should have been found in Central Europe, viz. *Spongilla Carteri* (previously only known to me in India, the Mauritius, and latterly in the island of Madura, on the E.N.E. coast of Java) by Dr. Thomas Margo, of Budapest, in Lake Balatan ('Annals,' 1882, vol. x. p. 369), and *Meyenia erinaceus*, which is the same as *Meyenia Leidy*, in the Spree and Elbe, by Leidy, and by Potts in the State of Pennsylvania, in North America.

From what has been above stated then it would appear that Ehrenberg gave the name of *Spongilla erinaceus* to this species in 1846, and Dr. Bowerbank the name of *Spongilla Leidy* to it in 1863.

Returning to the Altmühl-valley diluvium and that spicule above stated to be unknown to me, we are struck with the abundance of this *siliceous* refractive vermicular form, which is cylindrical and round at the extremities, but may be curved, inflated, sigmoid, contorted, branched, and indeed varied in an infinite number of such-like ways, below 10-6000ths inch in length and a little less in breadth than 1-6000th inch, which are the dimensions of the largest and straightest (although always somewhat curved) specimens that have come under my observation (fig. 18, *e*). Moreover it frequently presents itself in small groups or massive aggregations in the diluvium, wherein all the sizes and shapes appear together as if it grew from small to large in this way, and *naturally* existed in this condition (fig. 18, *d*). On account of its refractive character the central canal is seldom seen, but in one instance a central cavity was observed which was extended on both sides for a little distance in a linear form (fig. 18, *f*); otherwise I have not been able to detect any indication of its existence. To what this *siliceous* spicule could have belonged I am totally ignorant, since it is so entirely unlike any thing of the kind connected with the Spongillidæ that I have ever seen; yet it may be asked what it could come from but a *Spongilla* or a freshwater sponge. Herein lies the question; and therefore I describe and delineate so much of it as I know simply to call attention to the fact and to assist others in supplying an answer.

EXPLANATION OF THE ILLUSTRATIONS.

PLATE XIV.

Fig. 18. Contents of the Altmühl-valley diluvium. *a*, spiniferous spicule, characteristic average largest size; *b*, the same, smallest size; *c*, vermicular spicule; *h*, birotulate spicule; all drawn to the same scale, viz. 1-48th to 1-6000th inch, to show their sizes relatively. *d*, group or aggregated mass of vermicular spicules; *e*, various forms of the vermicular spicule; scale 1-24th to 1-6000th inch. *f*, vermicular spicule, more magnified, to show trace of a central canal. *g*, the smaller size of spiniferous spicule ("*b*"), more magnified, to show the form and recurvature of the spines in the smaller spicules generally; *i*, the birotulate "*h*," more magnified, to show the form of the shaft and arms; *k*, pollen-grain of Conifer; *l*, tetraspore of acotyledonous plant. The two latter on the scale of 1-24th to 1-6000th inch.

XXXVIII.—*Descriptions of two new Species of Asteroidea in the Collection of the British Museum.* By F. JEFFREY BELL, M.A.

THE *Asterias* now to be described was not satisfactorily recognized as an undescribed form at the time when I gave to the Zoological Society some account of the genus to which it belongs*. The *Culcita* has been long known to me as a new form, but I have refrained from publishing any account of it, in the hope that it might soon be possible to make a revision of the group to which it belongs. As it is now, however, exhibited in the new galleries of the Zoological Department at South Kensington, the student will probably find it convenient to have an account of it.

Asterias nautarum.

General formula, 2 ad.

Arms five, do not begin to taper till the last third of their length, broadest at a short distance from their base; two rows of adambulacral spines; madreporic plate anechinoplacid, obscure, not far from the margin of the disk. Spines autacanthid, very blunt on abactinal surface. The abactinal surface presents an appearance of very close packing, as there are on it three rows of autacanthid spines; those of the outermost are very fairly developed. This last-mentioned row bounds the lower, while a row as well marked bounds the

* P. Z. S. 1881, p. 492.

upper edge of the side of the arm; a few small spines are developed in the intermediate space. In addition to a not irregular row of spines which extends along the middle line of the abactinal surface, there are two irregular rows or lines of shorter spines on either side; all these spines are fairly strong, and all quite blunt at their tips. The disk is pretty thickly covered with spines.

Colour (after thirty years in spirit) creamy white, the suckers a little darker.

$R=49:r=10$, or R is nearly equal to $5r$.

Breadth of arms at base 9 millim., greatest breadth 11. .

Hab. Ecuador.

The description has been drawn up from a single specimen; others, not so well preserved, give the definite locality, and all were obtained from the collection of Haslar Hospital.

Standing nearer, perhaps, to *A. Brandti* than to any other species, *A. nautarum* is distinguished not only by its much shorter arms and stouter habit, its better developed though less numerous spines, but also by the fact that the skin-plates on which the spines stand are not so sharply separated from one another, so regularly set, or so well provided with granules, as in the more southern species from the Straits of Magellan. From *A. inermis*, which, like it, comes from the coasts of Ecuador, the new species is at once distinguished by its smaller disk, its longer arms, and its stronger stouter spines.

Culcita acutispinosa.

Resembling *C. coriacea*, and distinguished from all other species of the genus by the fact that the apices of the upturned ambulacra are below the level of the dorsal or abactinal surface. The body is almost completely discoidal in shape, the angles of the rays being very nearly altogether rounded off; the sides of the disk are very deep; in the dry specimens, at any rate, the actinal surface gradually slopes downwards, so that the animal is very much deeper along a line drawn dorso-ventrally through the actinostome than it is at the margin of the disk (62-40 millim.).

The adambulacral spines are in two rows; in the inner there are ordinarily four on each plate, and they are not so well developed as in some allied species; about five plates out from the actinostome they measure about 5 millim. in length. In the outer row there are generally two spines, one of which is very strong and blunt, while the other is much smaller. The spines on the intermediate plates sometimes lie quite close to the outer interambulacral series, and occasionally appear to invade it.

The actinal surface is not marked out into areolæ, and is richly invested by a number of short, blunt, stout processes, hardly to be called spines, amidst which a coarse granular covering is to be observed. The poriferous region begins quite suddenly, at about the second fourth of the length of the side of the disk (counting from the actinal margin); while this is the point at which the pores begin at the middle of each side of the disk, the line of demarcation gradually curves upwards, so that along the radial axes the pores begin just above the apex of the ambulacral groove. The greater part of the sides and the whole of the abactinal surface of the disk are covered with short sharp spines, which are scattered over them with considerable profusion, though in no definite order; dotted among the spines are pores of moderate size, which are very indistinctly grouped into pore-arcs; surrounding and separating the pores are fine granules, and these are, at apparently irregularly disposed points, closely aggregated into distinct patches; such a patch is found outside the spines which fringe the anus. On the abactinal surface the pedicellariæ are small and scarce; on the actinal they are, though small, much more numerous. The madreporic plate is large and raised above the surface. (It has unfortunately been injured in the specimen under description.)

The single dried specimen has the upper surface of a pinkish and the lower of a yellowish-white hue.

Hab. Aneiteum, New Hebrides

As already stated, the greatest height is 62 millim.; its diameter is 120 millim.

XXXIX.—*Descriptions of two new Species of the Genus Megalops (Coleoptera, Stenini).* By CHARLES O. WATERHOUSE.

Megalops ornatus, sp. n.

Niger, nitidus; thorace subcylindrico, ad latera sulcis quatuor fundo fortiter punctatis; elytris flavis nigro ornatis, in disco anteriore punctis nonnullis sut profundis biseriatis impressis, pedibus pal-
lide piceis.

Long. (mandib. incl.) $2\frac{1}{2}$ lin.

Mandibles pitchy. Head with a few strong punctures; on each side there is a slight longitudinal impression. Thorax in front about the same width as the head between the eyes,

a little broader before the middle, and then gradually (but not much) narrowed to the base. Close to the front margin there is a well-marked transverse impression scarcely interrupted in the middle; immediately behind this on the side there is a short sinuous impression, which does not reach the lateral margin; behind this is a third rather wider impression, which reaches the margin, and at the base a short but wide impression. Each of these impressions has a line of large punctures; those in the third one less distinct. The central portion of the surface is smooth, except for three or four deep punctures close to the base. The elytra are ample, nearly twice as broad as the thorax, a little broader than the head across the eyes, arcuate at the sides; yellow, with the shoulders, the outer apical angle, the suture, and a spot across the middle of the suture black. On the disk immediately below the shoulder are two approximate lines, each consisting of three or four large punctures; these punctures are in a shallow impression, and there is another impression occupied by the black spot across the suture. Antennæ pitchy, with the club fuscous.

Hab. Peru. Brit. Mus.

Megalops acutangulus, sp. n.

Niger, nitidus; capite thoraceque sat crebre fortissime punctatis; elytris picco-flavo ornatis, sat crebre punctatis, punctis in disco biserialim dispositis; abdominis marginibus reflexis piceis, pedibus sordide testaceis.

Long. 2 lin.

Head very broad, with large punctures irregularly scattered over the surface. Antennæ testaceous, with the apical two joints fuscous. Thorax with deep punctures rather closely placed over the surface, leaving the anterior margin smooth; in front of the same width as the head between the eyes, then suddenly wider, so as to make a somewhat acute projection, from which to the base it is gradually narrowed; the sides between the angular projection and the base rather straight. Above there are on each side two oblique smooth ridges, which unite near the anterior angle and diverge towards the middle of the thorax; and at a little distance from the posterior angle there is a small round swelling, in the centre of which there is a single large puncture. Elytra short, scarcely as broad as the head including the eyes, arcuate at the sides, with strong punctures rather closely placed in the sutural region (leaving the apex smooth) and at the sides; on the disk there are two lines of strong punctures (with a smooth ridge between them), the outer line extending to the apex.

Each elytron with a pitchy yellow line commencing in the middle of the base, and before it reaches the middle emitting a branch to the side and another to the sutural angle. Abdomen shining; the first to fourth segments with a few punctures at the base, and on each side two shallow somewhat cuneiform impressions; the fifth segment sparingly punctured, smooth at the apex, and with the *usual* white membranous border.

Hab. Java (J. C. Bowring, Esq.). Brit. Mus.

This species is interesting on account of the locality from which it comes. With the exception of two from Australia and one from Africa all the species are American.

British Museum,
Cromwell Road, London, S.W.
October 17, 1883.

XL.—On the Morphology of the Myriopoda.

By A. S. PACKARD, Jun. *

THE following notes have reference to the hard parts especially of the diplopod Myriopods.

The Head.—In the Chilognaths, which are the more primitive and in some respects the lowest group of the subclass, the Pauropoda excepted, the structure of the head is on a much simpler type than in the Chilopoda.

The epicranium constitutes the larger part of the head; it may be regarded as the homologue of that of hexapodous insects. Of the clypeus of Hexapoda there is apparently no true homologue in Myriopods; in the Lysiopetalid Chilognaths there is, however, an interantennal clypeal region slightly differentiated from the epicranium and forming the front of the head. In the Chilopods there is no well-marked clypeus, only a short, narrow, transverse preantennal clypeal region, to which the labrum is attached. Meinert, in his valuable and painstaking work on Myriopods, designates what we here call the epicranium the *lamina cephalica*; the division sometimes indicated in front next to the antennæ he calls *lamina frontalis discreta*.

The labrum in the Chilognaths is a short but broad sclerite, very persistent in form and not affording family or generic

* From the 'Proceedings of the American Philosophical Society,' Sept. 1883, p. 197; read June 16, 1883.

characters; it is emarginate on the sides, with a deep median notch containing three acute teeth. The labrum may on the whole be regarded as homologous with that of the Hexapoda, but is very broad and is immovable. Very different is the so-called labrum of the Chilognaths, which consists of two parts, a central portion, which may be homologized with the labrum of the Chilognaths, but is narrower, with a deep broad median notch, at the bottom of which is a central stout tooth.

In *Orya barbarica*, Gerv., according to Meinert, the labrum has a median suture, dividing it into two pieces, each with numerous fine teeth on the outer edge.

In *Dignathon microcephalum*, Lucas (Meinert, tab. ii. fig. 15), and in *Geophilus sodalis*, Bgs. and Mein., Meinert figures and describes the labrum as consisting of a *pars media* and two *partes laterales*, distinctly separated by suture; no such differentiation as this is known to us as occurring in the labrum of Hexapods.

This labrum is flanked on each side by a transverse sclerite, much broader than long; these pieces may be called the *epilabra*; to the outer edge of each is attached the cardo of the so-called mandible (*protomala*). What we have for brevity called the *epilabra* (fig. 1) are the "*laminæ fulcientes labri*" of Meinert*.

The so-called mandibles of the Myriopods are the morphological equivalents of those of insects, but structurally they are not homologous with them, but rather resemble the lacinia of the hexapodous maxilla. For this reason we propose the term *protomala* (*mala*, mandible) for the mandible of a Myriopod; *mala* would be preferable, but this has already been applied by Schödte to the inner lobes of the maxilla of certain Coleopterous larvæ.

The *protomala* consists of two portions, the *cardo* and *stipes*, while the hexapodous mandible is invariably composed of but one piece, to which the muscles are directly attached, and which corresponds to the *stipes* of the Myriopodous *protomala*. The *stipes*, instead of being simply toothed or with a plain cutting edge, as in Hexapoda, has, in the Chilognaths, two outer unequal long teeth, and within a series of singular processes like stout scæ, edged with dense spines on the inner side. This double apparatus of teeth and spinose processes,

* "Myriopoda Musei Havniensis. Bidrag til Myriopodernes Morphologi og Systematik," ved Fr. Meinert; 'Naturhistorisk Tidsskrift,' 3 R. 7 B. (Kjøbenhavn, 1871), p. 105 (see tab. i. fig. 4). Meinert states that the *laminæ fulcientes* do not belong to the labrum itself, and that the form of these pieces varies greatly according to the species.

which may be called the *pectinella*, gives the stipes a decided resemblance to that of the hexapodous maxilla. In the Chilopoda, according to the figures and description of Meinert, there is a greater variation in the nature of the pectinella of the stipes. As we have observed in the protomala of *Scolopendra* and *Lithobius*, there are three or more stout teeth, with an inner series of spinulated slender processes; but in several genera figured by Meinert, as *Mesocanthus albus*, Mein., *Scolioplanes crassipes*, Koch, *Chretochelyne vesuviana*, Newp., *Geophilus sodalis*, Bgs. and Mein., and *Mecistocephalus punctifrons*, Newp., the cutting edge is provided with spinose processes alone.

For the second pair of mouth-appendages of the Myriopoda we propose the term *deutomala*, or second pair of jaws. They form the so-called labium of Savigny and later authors. In the Chilognaths they have a superficial resemblance to the labium of winged insects; but the corresponding pair of appendages in Chilopoda are not only unlike the labium of Hexapoda, but entirely different in structure from the homologous parts in Chilognaths. The "labium" of Newport, or first maxillæ of Meinert, have been described and figured by those authors, to whose works the reader is referred.

The following remarks apply to the homologues of these parts in the Chilognaths. While most authors designate this pair of appendages as the "labium," Meinert more correctly calls them the first maxillæ, briefly, in the Latin abstract of his 'Danmark's Chilognather',*, in his diagnosis of the order describing them as "*Stipites maxillares* appendicibus instructi, detecti;" but in his description of *Julus* referring to them as "*Lamina labialis parva, stipites labiales inodo partim sejungens.*"

Meinert also describes what he designates as a third pair of mouth-parts or *labium*, which is enclosed by the second pair, behind which is a triangular plate (*lamina labialis*), which he regards as a sternal part corresponding to the mentum of insects. He then adds, "In front of the labium in the Polydesmidæ are two short round styles (*stili linguales*), which are toothed at the end." He also speaks of the curved piece behind the lamina labialis, which he designates as the *hypostoma* (see our fig. 2).

It should be observed that Savigny states that the labium (lèvre inférieure) is in *Julus* composed of what he designates as the first and second maxillæ, his second maxillæ being Meinert's *labium*.

* 'Naturhistorisk Tidsskrift,' 3 R. 5 B.

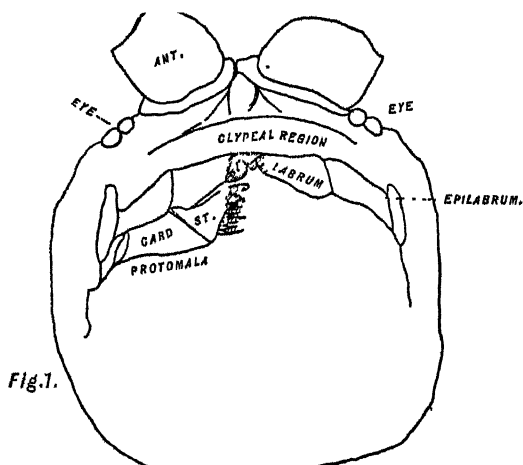


Fig. 1.

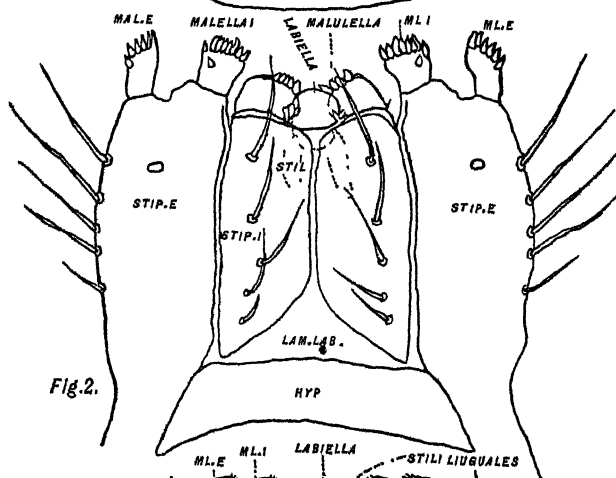


Fig. 2.

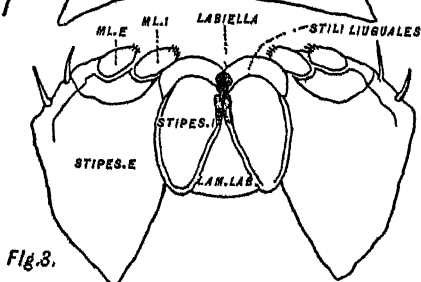


Fig. 3.

Fig. 1. Head of *Scolopendra*, seen from beneath, showing the "mandible" (protomala), with its cardo (card.) and stripes (sti.), also the labrum and epilabrum.

Fig. 2. So-called under lip or deutomala of *Sooterpes Copei*: hyp., "hypostoma"; lam. lab., lamina labialis; stip. e., stipes exterior; with the malella exterior (mal. e.) and malella interior (ml. i.); the stipes interior (stip. i.), with its malulella; and the labiella,

It seems to us that the researches of Metschnikoff* on the embryology of the Chilognaths (*Strongylosoma*, *Polydesmus*, and *Julus*) leave no doubt that these Myriopods have but two pairs of mouth-appendages, which Metschnikoff designates as mandibles and labium. The latter arises as a pair of tubercles or buds, at first of exactly the form of the mandibles, and like the primitive embryonic mouth-appendages of any arthropod. Hence the differentiations of parts and coalescence of the two limbs, while closely resembling that of the labium or second maxillæ of Hexapods, really occur in Myriopods in a different pair of appendages, i. e. the second instead of the third pair. Hence the parts called labium (many authors) in Myriopods are really homologous with the first maxillæ of insects; and they should, to prevent misconception, receive a distinctive name (*deutomalæ*). With the aid, then, of embryology we have arrived at a clearer conception of the homologies of the second pair of mouth-appendages in the Chilognaths. It forms a broad flat plate, becoming the floor of the mouth, and forming an under lip; it is differentiated into two sets of broad plates, an outer and inner stipes; the outer stipes (*stipes exterior*) bears at the free edge two movable toothed appendages, which may be designated as the inner and outer *malellæ*. The inner stipes (*stipes interior*) are united firmly and are supported behind by what Meinert designates as the *lamina labialis*, behind which is a curved broad sclerite, called by Meinert the *hypostoma*, a rather unfortunate name, as it has been used by Meigen and Bouché for the clypeus of Diptera. Differentiated from the front edge of the inner stipes is a piece usually separated by suture, which, as we understand it, is the *stilus lingualis* of Meinert; it is our *malulella*. A median portion of the deutomala has been apparently overlooked by authors; it is our *labiella* (fig. 2), and corresponds in a degree to the lingua of Hexapods; it is a minute rounded piece situated between the malulellæ, in *Julus* minute and single, in the Lysiopetalidæ much larger, and divided into a large anterior and a much smaller posterior crescent-shaped part; it is supported by two long cylindrical divaricating styles.

It thus appears that the head of Chilognaths bears but three pairs of appendages, viz. the antennæ and the mouth-appendages, the proto- and deutomalæ. Without doubt the Chilognaths, as proved by their embryology and morphology and their close relationship with the Pauropoda, the simplest Myriopods, represent the primary form of the Myriopods,

* "Embryologie der doppeltfüssigen Myriapoden (Chilognatha)," von Elias Metschnikoff, Zeitschrift für wissenschaftl. Zoologie, xxiv. p. 253 (1874).

while the Chilopods are a secondary less primitive group. Palæontology apparently supports this view. We may now turn to the structure of the head of Chilopod Myriopoda, which has been fully described by Newport* and also by Meinert†.

Having already briefly described the morphology of the epicranium or antennal segment of Chilopods, with the labrum and "mandibles" (protomalæ="true maxillæ" of Newport), which are close homologues of those of diplopod Myriopods, we may next take up the second pair of mouth-appendages, which are the morphological equivalents of the so-called labium of Chilognaths. These, as seen in *Scolopendra*, are very different from the so-called under lip of Chilognaths; they are not united, and are separate, cylindrical, fleshy, 5-jointed appendages, but, as Newport states, "connected transversely at their base with a pair of soft appendages (*c, c*) that are situated between them, and which, as I have already stated, I regard as the proper *lingua*, as they form the floor of the entrance to the pharynx." These 5-jointed appendages are Mr. Newport's "maxillary palpi," his true maxillæ being the homologues of the "mandibles" of Chilognaths.

The portion of the head of *Scolopendra* and other Chilopods, thus far considered, together with the antennæ and proto- and deutomalæ, we consider as homologous with the entire head of Chilognaths; the basilar segment of Newport and the two pairs of head-appendages have no homologues in the head of Chilognaths. They are rather analogous to the maxillipedes of Crustacea, and nothing like them, speaking morphologically, exists in other Tracheata. We therefore propose the term *malipedes* (*mala*, jaw, *pes*, foot or jaw-feet) for the fourth and fifth pair of cephalic appendages of Chilopoda. At the same time it is easy to see that they are modified feet, especially when we examine the last pair in *Scolopendra*, which are attached to a true sternite, and see that they are directly homologous with the feet and sternite of the same animal.

The first pair of malipedes are the "labium and palpi" of Newport, the "first auxiliary lip" of Savigny. They, however, bear little resemblance to an insect's labium and labial palpi. They are separate, not coalescing in the middle, as in the labium of Ilexapods. The so-called labial palpi are 4-jointed, with an accessory plate; they arise directly in front

* "Monograph of the Class Myriapoda, Order Chilopoda, with Observations on the General Arrangement of the Articulata," by George Newport (Trans. Linn. Soc. xix. p. 287).

† "Myriapoda Musei Havniensis. Bidrag til Myriapodernes Morphologi og Systematik," ved Fr. Meinert; 'Naturhistorisk Tidsskrift,' 3 R. 7 B. (1871).

of the "basilar segment" of Newport, but appear to have in adult life no tergite of their own*.

The second pair of malipedes or last pair of mouth-appendages are the poison-fangs; they are the "second auxiliary lip" of Savigny, the "mandibles or foot-jaws" of Newport and subsequent authors. The dorsal plate, or what may be called the *second malipedal tergite*, is the "basilar and sub-basilar plate" of Newport.

As to the number of segments in the head of Chilognaths, both morphology and embryology prove that there are but three, in the Chilopoda five. Newport's observations on the young recently-hatched *Geophilus* (his pl. xxxiii. fig. 3) show that the subbasilar plate is the tergum or scute of the fifth segment; and the basilar plate is consequently the tergum of the fourth segment or second malipedal segment. The sternite of the subbasilar plate is usually a very large plate, deeply indented in front in the middle, with teeth on each side, and forms the "labium" of Newport. It may, for convenience in descriptive zoology, be termed the "pseudo-labium."

As embryological proofs of our morphological views may be taken the admirable researches of Metschnikoff† on the development of *Geophilus*. His Taf. xx. fig. 4 shows plainly the four pairs of mouth-appendages behind the antennæ, the latter developed, as in Hexapods, from the procephalic lobes. His fig. 15 shows that the pleurum and tergum of two posterior (or fourth and fifth) cephalic arthromeres, with their appendages, are the primitive scuta of the proto- and deutomalaxar arthromeres, which at this period have coalesced and are intimately united with the procephalic lobes. His fig. 18 shows that at a later period the primitive scutum of the fourth cephalic segment has disappeared, or at least is merged into the fifth primitive scutum or subbasilar plate of the adult. An examination of Metschnikoff's paper will prove conclusively that Newport's views as to the subsegments of the Chilopods are not well founded in nature, and that they are merely for the most part simply adult superficial markings.

The following Table will serve to indicate in a comparative

* Balfour also states, as we find after writing the above, that the basilar plate is really the segment of the poison-claws, and may fuse more or less completely with the segments in front of and behind it, and the latter is sometimes without a pair of appendages (*Lithobius*, *Scutigera*). (Comp. Embryology, i. p. 225.)

† "Embryologisches, über *Geophilus*," von Elias Metschnikoff, Zeitschrift für wissenschaftl. Zoologie, xxv. p. 313 (1875).

way the number of arthromeres in the head of the three subclasses of Tracheate Arthropods, their corresponding appendages, and the more important synonyms:—

	Hexapoda.	Arachnida.	Myriopoda (Chilopoda).	Myriopoda (Chilognatha).
1st Arthromere (Preoral).	Antennæ.	Wanting *.	Antennæ.	Antennæ.
2nd Arthromere (Postoral).	Mandibula.	Chelicerae †. (Mandibles.)	Protomalæ. (Mandibles, Savigny.)	Protomalæ. (Mandibles, Savigny.)
3rd Arthromere	1st Maxillæ.	(Pedipalpi, maxillæ.)	Deutomalæ. (1st Maxillæ, Savigny.)	Deutomalæ. (Labium.)
4th "	2nd Maxillæ.	1st pair of bænopoda.	1st Malipedes. (1st Auxiliary lip, Savigny.)	2nd pair of Pedes.
5th "	2nd pair of bænopoda.	2nd Malipedes. (Auxiliary lip, Savigny; Mandibles.)	2nd pair of Pedes.
6th "	1st pair of bænopoda.	3rd pair of bænopoda.	1st pair of Pedes.	3rd pair of Pedes.

General Morphology of the Body.—The well-known researches of Newport on the development of *Julus*, and the embryological studies of Metschnikoff already referred to, show that the larva of *Julus* and other diplopod Myriopods is hatched with but three pairs of feet. In *Julus terrestris*, as stated by Newport, the third body-segment is apodous, the first, second, and fourth segments behind the head bearing feet. The body-segments are at first nine in number, the new segments appearing six at a time. In *Strongylosoma*, according to Metschnikoff, the larva has eight segments behind the head, the second segment footless; in *Polydesmus* there are but seven body-segments, the second apparently being apodous, though it is difficult to determine with certainty from the drawing which of the first three segments is apodous.

In two embryos of *Julus multistriatus*, Walsh?, kindly communicated to us by Prof. Riley, and which he assures us

* Balfour claims that the first pair of cephalic appendages are wanting; and the fact shown by his fig. 200, C, D, that the stomodæum at first lies between the procephalic lobes, and that the latter do not even bear appendages, appears to prove his statement.

† "On the Organs of Reproduction and the Development of the, Myriopoda," Phil. Trans. 1841.

were freshly hatched right from the egg, the larvæ are much more advanced than in the freshly-hatched larvæ referred to; still *the second body-segment is footless instead of the third*; but there are seventeen segments, the first, third, and fourth each bearing a single pair of legs; the fifth to the tenth segments each bearing two pairs of legs. In one of the three specimens, which was apparently a little longer out of the egg than the two others, there were five penultimate short secondary segments (eleventh to fifteenth) on which there were rudiments apparently of but a *single pair of legs* to each segment, whereas Newport states that two pairs bud out from each segment, and while in *Julus terrestris* the new segments arise in sixes, in our species they arise in fives. In adult life a single pair of limbs arises from the second segment, and the first three segments have each but one pair of legs, the fourth having two, as in the fifth and following segments.

It thus appears that the larval diplopod Myriopod is a six-footed Tracheate, though neither its mouth-parts nor its primary legs are directly homologous with those of the Hexapodous Insects.

Looking at the embryo diplopod Myriopod from a deductive or speculative point of view, it doubtless represents or is nearly allied to what was the primitive myriopodous type, a Tracheate, with a cylindrical body, whose head, clearly separated from the hind body, was composed of three cephalic segments, one pair of antennæ, succeeded by two postoral arthromeres, the protomalal and deutomalal arthromeres; while the hind body consisted of as few as seven arthromeres, whose scuta nearly met beneath, with three pairs of six-jointed legs distributed among the first four segments. It is evident that the form represented by the adult is a secondary later product, and arose by adaptation to its present form. The embryo *Geophilus*, the only Chilopod whose embryology has been studied, leaves the egg in the form of the adult; it has, unlike the Diplopods, no metamorphosis. Its embryological history is condensed, abbreviated.

But in examining Metschnikoff's sketches, primitive Chilognath characters assert themselves; the body of the embryo shortly before hatching is cylindrical; the sternal region is much narrower than in the adult, hence the insertions of the feet are nearer together, while the first six pairs of appendages (the sixth apparently the first pair of feet of the adult) are indicated before the hinder ones. These features indicate that the Chilopoda probably arose from a diplopod or diplopod-like ancestor, with a cylindrical body, narrow sternites, and with three pairs of legs, which represent those of the larval

Chilognaths, the two anterior becoming the two pairs of malipedes of the present Chilopoda. Thus the first six appendages of the embryo *Geophilus* correspond to the antennæ, two pairs of mouth-parts and three pairs of legs of the larval *Julus*.

The phenomenon of two pairs of limbs to a segment, so unique in Tracheata, may be explained by reference to the Phyllopoda among the Branchiata. The parallel is quite exact. The larvæ in both groups have but a single pair of appendages to a segment; the acquisition of a second pair in the Diplopods is clearly enough a secondary character, and perhaps necessary in locomotion in a cylindrical body with no sterna*.

The larval *Julus* and the ancestral Chilognaths were hexapod Tracheata, but sufficiently different to indicate plainly that the Myriopods branched off from a much more primitive form than the *Scolopendrella*-like hexapod ancestor, and which form somewhat agrees with our hypothetical leptiform ancestor of all Tracheata.

The Myriopods also differ from Hexapoda in that the genital armature of the male (the females have nothing corresponding to the ovipositor of Hexapoda) is not homologous with that of true insects; moreover, the armature is not homologous with the limbs or jointed appendages of the myriopodous body. On the contrary, the apparatus of hooks arises from the sternum of the sixth segment, between, but a little in advance of, the origin of the eighth pair of legs. It should be observed that the legs in Myriopods are outgrowths between the tergites and sternites, there being no pleurites differentiated, and in this important point also the Myriopods are quite unlike the Hexapodous Tracheates.

Affinity and Systematic Position of the Pauropoda.—The nearest living forms which approach the larval Diplopod are *Pauropus* and *Eurypauropus*. These organisms are practically primitive Diplopods. Looking at the lowest Chilognath, *Polyxenus*, and comparing *Pauropus* with it, it will be seen that the latter scarcely differs from it ordinarily. *Pauropus* has a head with a pair of antennæ and two pairs of mouth-appendages. The antennæ are quite unlike those of any other

* It is plain that, as Balfour suggests ('Comparative Embryology,' p. 324), the double segments have not originated from a fusion of two primitively distinct segments. There is, however, a misconception as to the nature of the "double segments." They are not so in fact. The scutes are single, undivided, but the ventral region is alone imperfectly double, bearing two pairs of appendages, just as single segments of Apodidæ may bear from two to six appendages; the differentiation is confined to the ventral limb-bearing region and limbs alone; the dorsal part of the segment does not share in the process.

Myriopods, being 5-jointed and bifurcate, somewhat as in certain Coleopterous larvæ; the peculiar sense-filaments may be the homologues of the flattened sense-setæ at the end of the antennæ of Diplopod Myriopods.

The "mandibles" are rudimentary, very simple, and are scarcely more like Chilopod than Diplopod protomalæ; there is a second pair of appendages which, as Lubbock states, are "minute and conical;" they bear a closer resemblance in position and general appearance to the "under lip" of Chilognaths, especially the under lip of *Siphonophora*; in fact, the mouth-appendages of *Pauropus* are much nearer the normal type of those of the true Chilognaths than the degraded mouth-organs of the Sugentia.

The body of *Pauropus* is cylindrical, the scutes are as much like those of *Polyxenus* as those of the Chilopods; the number of body-segments is seven, the same as in the larvæ of certain Diplopods; the feet are 6-jointed as in Diplopods, and there are nine pairs, six pairs to the four penultimate segments. The three anterior pairs are developed from two segments, *i. e.* arise from the ventral and lateral sclerites corresponding to two scutes. This fact should not, we venture to suggest, exclude them from the Chilognaths, as there is a considerable irregularity in the position of the three pairs of anterior feet in larval Chilognaths. The terminal body-segment is much as in Chilognaths. When we examine the larva of *Pauropus* we find a strong resemblance to the larval hexapodous Chilognaths. Hence we scarcely see good grounds for placing *Pauropus* in a distinct order from Chilognaths. Their distinctive characters, and they are important ones, are, we submit, only of subordinate value, and we should therefore place the Pauropoda as a second suborder of Chilognaths, throwing all the genuine Chilognaths into a first suborder.

Turning to *Eurypauropus* we find that this singular form is in a degree a connecting link between *Pauropus* and *Polyxenus*; the head has much the same shape, the antennæ being inserted beneath far back from the front edge of the broad top; the legs are of much the same shape, and more truly diplopod than in *Pauropus*, and they are arranged nearly in two pairs to a segment; there are six segments, four of them bearing legs, there being nine pairs of legs to four scuta. The scutes are much as in *Polyxenus*, spreading out flat on the sides, the animal being elliptical oblong, broad and flat. There are no true sternites like those of Chilopods; and though the feet are inserted wider apart, the entire structure of the soft membranous sternal region is much as in *Polyxenus*. We therefore feel warranted, although originally accepting the ordinal rank

of the Pauropoda assigned them by Sir John Lubbock, in regarding them as Chilognaths, with aberrant features which would throw them into a suborder of the latter group.

The Systematic Position of Scolopendrella.—This singular form is usually regarded as a Myriopod, while Mr. Ryder refers it to a distinct order, Symphyla. We have already* given our reasons for the view that it is a Thysanuran†, with only superficial resemblances to the Chilopod Myriopods. Our fresh studies on the latter confirm our opinion that *Scolopendrella* is a Hexapod. The mandibles and maxillæ, the former especially, are like those of the Thysanura rather than the Myriopods, not being divided into two parts (stipes and cardo). It seems to us that *Scolopendrella* with its numerous postcephalic legs may fulfil the phylogenic requirements of the early embryo of Hexapoda and Arachnida in which there are a number of embryonic primitive abdominal appendages. Thus it preceded *Campodea* as a stem-form.

Genealogy of the Myriopoda.—The pseudo-hexapodous larval forms of Chilognatha, including the Pauropoda and the early germ of the Chilopoda (*Geophilus*), indicate that the many-legged adults were derived from what we have called a *Leptus*-form ancestor. Our present knowledge of the embryology of the Myriopoda shows that, unlike the Arachnida and Hexapoda, the embryo is not provided with primitive transitory legs. There seems then no direct proof that the Myriopoda had an origin common with that of Insects and Arachnida, from a *Scolopendrella*-like, and perhaps still earlier *Peripatus*-like ancestor; but from a six-legged form, which, however, may have been derived from some worm-like ancestor. The *Leptus*-form larvæ of Myriopoda, with their three pairs of cephalic appendages and six legs, may then be the genealogical equivalent of the six-legged Nauplius of Crustacea; which type is generally believed to have originated from the worms.

A genealogical tree of the Myriopods would then be simply two branches, one representing the Diplopod and the other the single-paired type (Chilopoda), both originating from a *Leptus*-like six-footed ancestor (*i. e.* with three pairs of cephalic and three pairs of postcephalic appendages).

Dr. Erich Haase, in his "Beitrag zur Phylogenie und Ontogenie der Chilopoden," publishes a "Stammbaum der

* 'American Naturalist,' xv. p. 698 (Sept. 1881).

† Compare the excellent figures of the mouth-parts of *Scolopendrella* in Dr. I. Muhr, "Die Mundtheile in *Scolopendrella* und *Polyzonium*," 10er Jahresbericht über das deutsche Staats-Gymnasium in Prag-Altsstadt, 1881-82. Prag, 1882.

Protochilopoden." He proposes a hypothetical group, Protosymphyla, from which the Symphyla, Thysanura, and Chilopoda have originated. But, as we have seen, this view is based on mistaken views as to the relations of the Chilopods to the Diplopod Myriopods, and of the homologies of Myriopods with Insects. As we have seen, the Chilopods must have originated from a Chilognathous stock, or at least from a branch which arose from *Pauropus*-like forms, and the Thysanura, with *Scolopendrella*, must have arisen from a separate main branch, which led to the Hexapodous branch of the Arthropod genealogical tree.

For the reasons stated, also, we should disagree with the views of Hckel ('Natrliche Schpfungsgeschichte,' 1870, 2nd edit.) that the Diplopod Myriopods were derived from the Chilopoda. In the English translation (1876) he remarks, "But these animals also originally developed out of a six-legged form of Tracheata, as is distinctly proved by the individual development of the millipede in the egg. Their embryos have at first only three pairs of legs, like genuine insects, and only at a later period do the posterior pairs of legs bud, one by one, from the growing rings of the hinder body. Of the two orders of Centipedes . . . the round *double-footed* ones (Diplopoda) probably did not develop until a later period out of the older flat *single-footed* ones (Chilopoda), by successive pairs of rings of the body uniting together. Fossil remains of the Chilopoda are first mentioned in the Jura period." The Chilognaths, however, as shown by Dawson, Meek, and Worthen, and latterly by Scudder, were numerous as far back as the Carboniferous period; the Chilopods are the later productions, perhaps not older than the Tertiary period, since Germar's *Geophilus proavus* is a doubtful form.

In this connexion reference should be made to the singular fossil, *Palocampa*, from the Carboniferous formation of Illinois, originally described as a caterpillar-like form by Meek and Worthen, and lately claimed to be a Myriopod by Mr. Scudder*, who proposes for the hypothetical group, of which he considers it as the type, the name *Protosyngnatha*. It seems to us, after a careful reading of Mr. Scudder's article, that this obscure fossil presents no features really peculiar to the Myriopods, but that there are as good or better reasons for regarding it as the hairy larva of some Carboniferous neuropterous insect. Mr. Scudder describes it substantially

* "The Affinities of *Palocampa*, Meek and Worthen, as evidence of the wide diversity of type in the earliest known Myriopods," by Samuel H. Scudder. Amer. Journ. Science, xxiv. no. 141, p. 161 (Sept. 1882).

thus :—"It is a caterpillar-like segmented creature, three or four centimeters long, composed of ten similar and equal segments, besides a small head; each of the segments, excepting the head, bears a single pair of stout, clumsy, subfusiform, bluntly-pointed legs, as long as the width of the body, and apparently composed of several equal joints. Each segment also bears four cylindrical but spreading bunches of very densely packed, stiff, slender, bluntly tipped, rod-like spines, a little longer than the legs. The bunches are seated on mammillæ and arranged in dorsopleural and lateral rows."

We do not recognize in this description any characters of a myriopodous nature; on the contrary, in what is said about the head, "composed of only a single apparent segment" (p. 165), and of the legs in the above description, and again on p. 165, where it is remarked, "The legs were different in form [from those of modern Chilopoda], but their poor preservation in the only specimen in which they have been seen, prevents any thing more than the mere statement of the following difference; while the legs of Chilopoda are invariably horny, slender, adapted to wide extension and rapid movement, those of *Palæocampa* are fleshy, or at best subcoriaceous, very stout and conical, certainly incapable of rapid movement, and serving rather as props," the author appears to be describing rather a caterpillar-like form than a Myriopod. It seems to us that the larvæ of the neuropterous Panorpidae, with their two-jointed abdominal prop-legs, small head, and singularly large spinose spines, arising in groups from a tubercle or mamilla, come nearer to *Palæocampa* than any Myriopod with which science is at present acquainted. For these reasons, and while the nature of these fossils is so problematical, we should exclude them, as regards the Myriopods, from any genealogical considerations.

We have also attempted to show that the Archipolypoda* are a subdivision of Chilognathis, allied not remotely to the Lysipetalidae; or at least that they are true diplopod Myriopods. Hence we are still reduced for our materials for a phylogeny of the Myriopods to existing orders, *Pauropus* being, perhaps, a more aberrant and stranger type than any fossil forms yet discovered.

* "The Systematic Positions of the Archipolypoda, a Group of Fossil Myriopods," Amer. Naturalist, 326, March 1883.

XLI.—*Contributions to a Knowledge of Malayan Entomology*.
Part II. By W. L. DISTANT.

Order LEPIDOPTERA.

RHOPALOCERA.

Elynnias Godferyi, n. sp.

Allied to *E. vasudera*, Moore, but differing above by the much paler colouring of the wings, the fuscous shadings in the Indian species being replaced by bluish; the anterior wings are greyish white, shaded with bluish, which becomes darker beyond the cell; a broad outer marginal dull bluish-black fascia, widest at apex; nervures and nervules dark bluish, the median nervules and submedian nervure more or less margined with dark bluish; posterior wings as in *E. vasudera*, but the markings bluish and the outer margin very broad at anal angle. Wings beneath as in *E. vasudera*, but the dark mottled markings much smaller and closer; anterior wings with two small submarginal ocellated spots (black, with greyish centres), divided by the lower discoidal nervule; posterior wings with eight similar submarginal spots, the two uppermost largest, the first between and near the bases of the subcostal nervules, the second above the discoidal nervule, and the remaining spots following regularly between the nervules—two between the third median nervule and submedian nervure—(anal angle mutilated); the red basal colouring of the posterior wings occupies the largest portion of the cell, and extends to the base of the abdominal margin; the yellowish space does not extend from the abdominal margin to the upper median nervule, as in *P. vasudera*, but terminates suddenly at the second median nervule.

Exp. wings 70 millim. *

Hab. Malay peninsula, Sungei Ujong (*Godfery*).

Ixias Birdi, n. sp.

♂. Anterior wing black; basal third (consisting of lower and inner half of cell obliquely terminating at a little beyond base of lower median nervule, and from thence continued to inner margin at about one fourth from posterior angle) sulphureous; the black area is inwardly angulated beneath the lower median nervule, and is crossed by a broad irregular orange-coloured fascia, divided by the black nervules, commencing a little above the costal nervure, and outwardly oblique

to upper discoidal nervule, then convexly suberect to upper median nervule, after which it is outwardly elongated, and terminates at about the lower median nervule; inwardly it is excavated at the discocellular nervules, before which and in the cell it possesses an extension of two irregular spots. Posterior wings sulphureous, with a broad outer black margin. Wings beneath sulphureous; anterior wings faintly showing the orange-coloured fascia above, sparingly speckled with fuscous in upper portion of cell and along the costal and outer margins (most broadly so at apex), and with a fuscous spot at posterior angle; posterior wings also sparingly speckled with fuscous. Body and legs more or less concolorous with wings.

Exp. wing 56 millim.

Hab. Malay peninsula, Sungei Ujong (*Godfery*).

This species is allied to *I. anexibia*, Hübn., and *I. latifasciatus*, Butl.; from both it differs by the narrower black marginal border to the posterior wings, and on the anterior wings by the greater extension of the black area across the cell, and also from the first by the paler-coloured orange fascia, which is also more dilated beneath the upper median nervule.

Papilio caunus, Westw., race *ægialus*.

♂. Closely allied to *P. caunus*, but differing in having the white markings with their pale bluish terminations on the upper surface of the posterior wings smaller and more confined to the basal half.

Hab. Singapore (*Godfery*).

Exp. of wings 94 millim.

The interest attaching to this local race of *P. caunus*, and on account of which it is here described, is owing to its being a mimic of *Euphrea diocletianus*, which is also the local race or form in the Malay peninsula of *E. rhadamanthus*. We thus see this mimicking *Papilio* modified in the same manner as its mimicked species; and if *E. diocletianus* is recognized as a distinct species, this race, if found to be constant, will have (in an artificial and systematic sense only) to be recorded in the same way. The Bornean form of this *Papilio* will also probably be found to mimic the race or species *Euphrea Lowei*.

Discophora tullia, Cram.

Messrs. Marshall and De Nicéville, in their 'Butterflies of India,' vol. i. p. 299, have expressed their opinion that the

male and female specimens that I figured in my 'Rhopalocera Malayana,' as representing Cramer's species, must be really taken to portray *Discophora zal*, Westw. I cannot subscribe to this somewhat surprising decision, on the following grounds:—

First:—The varietal male specimen which I figured, and which agreed with all male specimens then examined from the Malay peninsula in having the anterior wings unspotted, cannot in any case be considered a distinct "Malayan race," as I have since received specimens from Sungei Ujong with two of the three series of bluish spots described as typical of the Indian form of the species, but which are certainly not constant. But even supposing that the unspotted form was constant and constituted a distinct race, it could not then be taken as representing the *D. zal* (the male of which was unknown to Prof. Westwood when he described that species), as Mr. Moore possesses in his collection a male which he tells me agrees with the markings of the female of that species, and may therefore be considered typical.

Secondly:—The female form which I figured does not agree with the original figure given by Westwood, which possesses a fourth inner row of spots, and also has the two outer series composed of differently-shaped spots.

If, therefore, *D. zal* is really specifically distinct from *D. tullia*, as Mr. Moore's male specimen would denote, it certainly cannot be ascribed to my Malay specimens and figures, as stated by Marshall and De Nicéville; and as these figures undoubtedly show variation from the Indian form of *D. tullia*, as understood and figured by them, the course pursued should have been either to agree with me or to describe the Malay form as a new species!—the last being an alternative that I, at least, am not prepared to take.

MISCELLANEOUS.

Lucilia macellaria infesting Man.

By FREDERICK HUMBERT, M.D., F.C.S.

A FARMER's wife, thirty-five years of age, was attacked on Monday, September 27, 1875, with a headache and a flushed face. She stayed at work, expecting a malarial chill, an affection prevailing at that time in the neighbourhood. From this time the pains in the region of the frontal cavity at the base of the nose and below the eye, extending to the right ear, increased. At times the pain was

more severe than at others, but it never entirely left. This pain was described as preventing hearing and breathing, and so excruciating that at intervals, day and night, her cries could be heard at a great distance from the house. Tuesday evening blood-mucus began to run from the right nostril, which was somewhat swollen, the swelling extending on Tuesday over the whole right side of the face. On this day, the fifth of the complaint, four large maggots dropped out of the right nostril. When I was first called to the patient, Monday, October 4, only the right lip and nostril were swollen, the acrid discharge having somewhat blistered the lips below. After each discharge the maggots dropped from the nostril, until the twelfth day; one hundred and forty or more maggots having escaped. The majority of the maggots were three fourths of an inch in length, there being only a few which seemed a line or two shorter; they were of a yellow hue, conical shape, and having attached to one end two horn-like hooks. The patient recovered fully.

Monday, September 18, 1882, I saw a patient in the same neighbourhood as the first, suffering from the same malady. At that time two hundred and eighty maggots had been discharged, and at the close of the illness over three hundred. There was a swelling on each side of the nose, with a small opening to each. I lanced these openings and more maggots came out.

In the Indian Territory the so-called screw-fly laid its eggs in the nose of man. In 1847 I heard of several deaths of men and children in Texas, near Dallas. The gad-fly was common in the American Bottom forty years ago. It laid its eggs in the noses of cattle and in the ears of horses and deer, but never in the human nose. The fly that I send is about four times as large as the common fly. Head a dark, glistening green; a bronze face, very lively in appearance. Is it the same that they called in Texas or Indian Territory the screw-fly? or is it the gad-fly seeking a new field?

The patient of 1875 is now alive and well. The second case occurred two years ago near Collinsville, in this county, and proved fatal. The third patient above named is getting well. The fourth is reported from Georgia; the patient died.

The first case which I had under my charge was the first which ever occurred here. The eggs must have been deposited in the nose several days before the fifth, the day the maggots dropped out. On the eleventh day all were discharged. I scoured live maggots at that time, September 18, 1882. I put soil in an open-mouthed vial and dropped the maggots on it; they crawled in the ground in about five minutes. I covered the opening with white damastis and hoped that the next year the fly would come out of the ground. But on October 6, or the twentieth day, the vial had fourteen living flies. So, reckoning from six days before the pain commenced for the laying of the eggs, to the twelfth day, when the maggot discharged, making eighteen days, and to this adding the twenty days during which the grubs were in the ground, we have thirty-eight

days from the time the fly laid the eggs until a new generation of flies is produced from them.

You may think I have dwelt too long on these cases; but if you had to stand at the bed and had seen the suffering and despair of the patients and found that the worms were eating them up, you would not think so.

All these cases occurred in the month of September.

Upon this communication Dr. C. V. Riley says that the insect here referred to as attacking the human subject in Illinois, "is the *Lucilia macellaria* of Fabricius, the injuries of which to different animals are well known in the south and west, where the larva is called the 'screw-worm.' I have repeatedly endeavoured to obtain the true parent of this worm. Dr. Humbert's communication is most interesting, but the specimens yet more so, as the flies he forwards are the first that have positively been bred from the larvæ known as 'screw-worms,' and they confirm the above determination of the species. The larvæ agree with others which I have from Texas, taken from the root of the ear of a hog which had been bitten by a dog."—*Proc. U.S. Nat. Mus.* Sept. 1883, p. 103.

Fish Mortality in the Gulf of Mexico.

By S. T. WALKER*.

Knowing your interest in every thing connected with fish &c., I take the liberty of giving you all the facts I have been able to collect in reference to the late mortality among the fishes in Tampa Bay and adjoining coasts. Had I known before I began my cruise of the extent of this mortality and splendid opportunities afforded of collecting specimens of strange and perhaps unknown species, I might have gone better prepared for collecting specimens; but I had only heard a few vague rumours, and I was little prepared for any thing further than a collection of facts in regard to the matter.

On leaving Clear Water, November 20, I sailed south through Boca Ceiga Bay, and encountered the first dead fish floating on the water near Bird Key, a little south-east of Pass A'Trilla. These were mullet, and as we progressed to the south and east I began to encounter toad-fish, eels, puff-fish, and cow-fish, in immense numbers, and, on attempting to land on the extreme point of Point Pinellas for the night, I was driven to my boat by the stench of thousands of rotting fish upon the beach. The next morning I went ashore and found the dead fish drifted ashore in countless numbers. The eels appeared most numerous, followed by puff-fish, cow-fish, sailor's choice, and small fish of every shape and variety. After these followed groupers, mangrove snappers, jew-fish, gar-pike, spade-fish, sting-rays, and sharks. Other varieties, unknown to me, were mixed among these, together with vast numbers of cat-fish. I saw very few mullet here.

* Letter to Prof. S. F. Baird.

At Gadsden Point about the same species appeared; while at Tampa I saw but few dead fish, and they were principally gars and catfish. From Tampa I proceeded to the mouth of the Little Manatee to obtain some information from Mrs. Hoy concerning her theory accounting for the death of the fishes. I subsequently visited the towns of Manatee, Palmetto, Bradenton, and proceeded thence to Hunter's Point, in Sarasota Pass, Longboat Inlet being the furthest point south visited. Returning, I spent several days on Anna Maria Key, where I collected the skulls of several kinds of fish; thence, passing northward by way of Passage Key, Egmont, Mullet Key, and so on back to Clear Water. From Longboat Inlet round to Mullet Key, the dead fish were principally mullet, catfish, eels, and groupers, the mullet preponderating at least ten to one. Puff-fish, toad-fish, cow-fish, and frog-fish were still extremely plentiful; indeed, I saw no diminution in their numbers, though the numbers of dead mullet had increased very greatly.

I saw many fish in every stage of sickness, from the first attack to the end. All were affected in nearly the same manner. The fish, apparently active and healthy, would be swimming along, when suddenly it would turn on its side and shoot up to the top of the water, gasping as though out of the water, apparently unable to control its motions, often lying on its side on the bottom for five or ten minutes motionless, then suddenly shooting hither and thither without aim or object, and finally ending the struggle on the surface and floating off dead. Whole schools of mullet would suddenly stand upright on their tails, spouting water, and die in five minutes. Gars would run for a long time with their snouts above the water, and then lie motionless, as if dead, for ten or fifteen minutes. These generally lived an hour or more after being attacked. I obtained specimens of water from various localities, which I send herewith, marked to show whence obtained.

Before giving the statements of others in regard to the matter, I will give you the results of my own observation in a very brief manner:—

1. The dead fish were most numerous on the outside beaches and on the inside beaches of the outer line of keys.
2. The dead fish were least numerous about the mouths of creeks and rivers, decreasing gradually as one approached such places.
3. The poisoned water was not diffused generally, but ran in streams of various sizes, as proven by fish dying in vast numbers instantly upon reaching such localities.
4. The fish were killed by a specific poison, as proven by the sickness and death of birds which ate of the dead fish.
5. The fish began dying on the outside beaches first, as Mr. Strand, assistant light-keeper at Egmont, reports them coming up first on the 17th of October, while Mrs. Hoy observed them first on the 1st or 2nd of November, at Little Manatee river.
6. The examination of many hundred recently-dead fish revealed no signs of disease. The colours were bright, the flesh firm, and the gills rosy. The stomach and intestines appeared healthy.

In my haste I have neglected to state that I saw a good many dead birds during the trip. At Tampa ducks were dying. I saw dead vultures at Anna Maria Key, and at Passage Key large flocks of cormorants were sick and dying. I also saw the carcasses of terns, gulls, and frigate-birds. The cormorants sat on the beach with their heads under their wings, and could be approached and handled.

It might be also proper to state that on Monday morning, December 14, about one hour before day, I heard a roaring south-west of Passage Key, apparently far out at sea, resembling the "blowing off" of a steam-boiler. The noise continued some ten minutes and ceased. After daylight I heard a similar roaring, which lasted about five minutes. There was no steamer in sight in the direction of the sound, and I observed no swell in the sea following it. After I got under sail I heard the noise a third time. Whether this was followed by the death of fish I am unable to say, as I did not stay to see. I mention this incidentally as a corroboration of Mrs. Hoy's statement, which is hereto appended. Whether or not either of these disturbances of the water had any connexion with the mortality among the fishes, the theory of subaqueous eruptions of poisonous gases is extremely plausible and reasonable.

Statement of Mrs. Charles Hoy, of Little Manatee.

The fish began dying here about the 1st of November. About 8 o'clock on the evening of October 28, or thereabout, I was sitting on my front gallery, the air being perfectly still and the bay calm, when I heard a heavy splashing of the water in the direction of Gadsden Point. This continued for a few minutes and was immediately followed by a roaring sound, such as might be made by the wheels of a side-wheel steamer near at hand, though the noise seemed to be several miles away. This continued for about a quarter of an hour, as near as I could guess, when it suddenly ceased. Some twenty-five or thirty minutes afterwards heavy swells began to come up the river, such as come in during a heavy blow from the north-west. These continued for a long time, gradually becoming lighter until I went to bed. In three days the fish began to come up the river dead and dying. I caught several mullet that were standing upright in the water, sick, and each had three black spots on the back, which gradually faded away. I opened the fish and could see nothing the matter with them. The flesh was natural and firm and the gills were normal.

In regard to oysters I have had a rather rough experience, and can with certainty say that they are poisonous. A few days after the fish began dying I had a quart of fine oysters for dinner. I had a lady visitor on that day, but she did not like oysters, and ate none. My daughter and I ate heartily of them, and after dinner I took my gun and went out to a pond to shoot some ducks. I took a coloured woman (my cook) along, and before I had gotten half way I began to feel weak, and a mist came before my eyes. I kept on, however, to the pond, and when I reached it was so blind I

could not see the ducks, although the water was covered with them.

With the assistance of the coloured woman I got home, when I found my daughter similarly affected and unable to walk. Neither Mrs. Simms (the visitor) nor my cook were affected, which makes me know it was the oysters. The sickness and loss of vision gradually left us after drinking a cup of strong coffee. I am confident the death of the fish is caused by the discharge of poisonous gases from the bottom of the sea.

Mr. Williams, of Point Pinellas, thinks the mortality is "caused by a black scum on the water resembling soot," and Mr. Spencer, of the Tampa Tribune, says that "the water where the fish are dying looks black and slimy;" and he ascribes this to the fall of an unusual amount of rain, the water of which, "becoming impregnated with the poison of decaying vegetation, is poured into the bay in unusual quantities and poisons the fish." Both these gentlemen allude to the unwholesomeness of the oysters; and the latter says, "the oyster-saloons here [Tampa] were obliged to close, as the oysters came near killing several people." According to MM. Forgarty and Whittaker, "the poisoned water runs in streaks," so that, of three smacks fishing in company, "two lost all their fish, while one lost none, the vessels being only a few hundred yards apart."—*Proc. U.S. Nat. Mus.*, Sept. 1883, pp. 105, 107.

On the Organization of the Crinoidea.

By M. E. PERRIER.

In the course of investigations which already date from several years ago, I was led to results with regard to the organization of the arms of the Comatulæ differing considerably from those which were announced by William Carpenter, and which have been since observed and variously interpreted by Herbert Carpenter, Greef, Tauber, Ludwig, and some other observers. In consequence of the peculiar facilities for study which they presented I had made my investigations principally upon very young individuals, or upon arms in process of regeneration; it was, on the contrary, upon adult individuals, and often in full production, that the researches of the anatomists just cited were made. Hence it was probable that the divergences which existed between my original results and theirs might be due to the fact that the organization of the arms of Comatulæ undergoes important modifications with age. On the other hand, there are also serious divergences between the conclusions at which the various observers have arrived; and the publications of Ludwig have recently diffused ideas with respect to the Echinoderms which require to be rectified upon many points, ideas which we believe we have demonstrated to be incorrect with regard to the circulatory apparatus of the Urchins and Starfishes, and which would render any homology very difficult to establish in the group Echinodermata, if we accepted them for the Crinoids. This is

what has led us to resume the study of the development and organization of the Comatulæ from the moment when the larva attaches itself up to the adult state. Being compelled for the present to interrupt these investigations during my voyage on board the 'Talisman,' I beg the Academy's permission to communicate to it the principal results at which I think I have arrived.

Ludwig has described, in the Comatulæ, a complicated circulatory apparatus, the centre of which is a peculiar organ, sometimes called the *heart*, sometimes the *dorsal organ*, and which is a vascular plexus corresponding to the supposed *hearts* of the Starfishes, Sea-Urchins, and Ophiuri. M. Jourdain was one of the first to express doubts as to the nature of the organ regarded as a heart in the Starfishes; I have demonstrated that in the Sea-Urchins and Starfishes this organ had a glandular structure—a result which has been confirmed by recent researches upon the Ophiuri and the Sea-Urchins. The dorsal organ of the Crinoids has the same structure as the supposed heart of the other Echinodermata; like this it must be designated by the name of the *ovoid gland*. The vessels which appear to start from it are nothing but ramifications of the gland, usually terminating in dilatations having the aspect of *cæca*. These ramifications run in the midst of innumerable trabeculæ of conjunctive tissue of the general cavity, which may themselves sometimes take on the appearance of vessels. In the Comatulæ, in the Pentaerinoïd and in the Cystidean phase the ovoid gland already exists; it is a solid fusiform body, passing from the oral ring to the peduncle, of which it continues the axial cord. This body emits no ramification; there can therefore, at this moment, be no question of a vascular apparatus. In the adult Comatula the ovoid body is implanted upon one of the horizontal floors of the *chambered organ*.

The name given to this singular-looking organ shows that we know nothing of its physiological function. Nevertheless this function must be very important, for the chambered organ, of which scarcely the rudiments exist during the Cystidean phases, becomes developed in proportion as the Comatula acquires arms and cirri, and continues in connexion with all these parts by the intermediation of fibro-cellular cords which occupy the axis of the calcareous part of the cirri and the arms. The determination of the nature of these cords may seem to determine the nature of the chambered organ itself. William and Herbert Carpenter see the nervous system in these cords; Ludwig simply designates them as *fibrous cords*, and with him the nervous system is only a simple modification of the epithelium of the ambulacral groove.

I have been able to demonstrate not only that the fibro-cellular cords in question emit ramifications which have all the appearance of true nerves, as seen by W. and H. Carpenter, but also that, wherever muscles exist, these muscles are clearly in connexion with ramifications of the fibrous cord. These ramifications divide into a great number of threads; their last branches terminate at stellate cells, each of which is produced into a muscular fibre. Ramifications of this kind are likewise connected with the fibres which

are contained by the ambulacral tentacles, and a great number of which exist in the sensitive papillæ of these tentacles, which Ludwig erroneously regards as hollow.

This double connexion of the axial cords of the arms and the cirri with the organs of sense and those of movement confirms the opinion put forward by the English authors. But it must be added that the stellate cells which form the external covering of the cords are themselves in connexion with the cells of connective tissue which fill all the intervals of the calcareous trabeculæ of the skeleton of the animal, cells which themselves form a continuous network, the last meshes of which are connected with the cells of the epithelium of the arms.

In accordance with the close relationships which exist between all the tissues of the animal, the nervous system consequently remains in a state of remarkable indifferentiation. However it may be, if we assume that the axial cords of the cirri and arms are, as indicated by their anatomical connexions, dependencies of the nervous system, the chambered organ must be considered the central part of that system in the Crinoids; and these are important conclusions, the morphological consequences of which we shall reserve for future development.

In the parts of the arms in process of formation the tissue of the axial cord does not differ from the three yellow cells which surround it. It is by their free extremities that the arms increase in length. There exists a sort of terminal bud, which soon divides into two at first identical parts: one of these parts grows rapidly, and becomes a pinnule; the other elongates more slowly, and becomes again divided; the half opposite the newly-formed pinnule becomes in its turn a pinnule, and the bud included between the two pinnules continues this mode of division until the growth comes to an end. From this it results that the structure of the arms and that of the pinnules are at first identical. If the pinnule continues its evolution it becomes a ramification of the arm, and in this way we explain the mode of construction of the multistylate Comatulæ. When the pinnule stops in its evolution it appears to be only a simple appendage; it presents an ambulacral canal, and below this a general cavity, which is usually divided into two very unequal chambers by a transverse partition. This structure is also that of the very young arms, in which the inferior chamber is extremely small. When the genital apparatus is developed this structure becomes more complicated. The large chamber of the general cavity is divided afresh into three cavities by the appearance of a horizontal floor and a vertical floor. At the point of junction of these two floors there is a canal occupied in great part by the genital rhachis, the ramifications of which in the pinnules become the ovaries or the testes. I have been able to trace all these modifications, and I propose shortly to make them known in all their details.—*Comptes Rendus*, July 16, 1883, p. 187.

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XLII.—*Remarks on an Essay by Prof. G. Lindström, entitled "Contributions to the Actinology of the Atlantic Ocean," and a Reply to some of his Criticisms.* By Prof. P. MARTIN DUNCAN, F.R.S., V.P.G.S., &c.

IN 1876 Prof. Lindström communicated his essay * on the actinology of the Atlantic Ocean to the Royal Swedish Academy. It contained descriptions of corals which had been dredged up from off the Josephine Bank and the sea-floor near the Azores, Virgin Islands, Salt Island, and Anguilla. The depths varied from 109 to 980 fathoms.

After reading the essay carefully and comparing Prof. Lindström's statements with those of his predecessors in the same kind of research, I found that he differed from everybody in opinion, and often in matters of fact. I have hitherto carefully avoided disputation in scientific matters, and I felt no disposition to reply to Prof. Lindström, especially as I was aware how erroneous many of his statements were. I hoped that time would bring some remarks from him after M. de Pourtalès and Prof. H. N. Moseley, F.R.S., had contravened some of his assertions. But lately having been engaged in a

* Kongl. Svenska Vetenskaps-Akad. Handl. Bd. xiv. no. 6, published in 1877.

revision of the genera of corals, it was necessary for me to reconsider the essay on the actinology of the Atlantic.

Much has been written upon the deep-sea corals since Prof. Lindström's essay was read. Thus my paper on the *Madreporaria* dredged up by H.M.S. 'Porcupine' was read May 1876 and published in 1878 (Trans. Zool. Soc. vol. x. part 5, 1878).

Prof. H. N. Moseley's preliminary report on the 'Challenger' corals (1875) was followed in 1879 by the reception of his full report on the 'Challenger' corals. This book was published subsequently.

The late M. de Pourtales published the Report on the Corals and Antipatharia of the 'Blake' Expedition in 1880.

These researches might have modified Prof. Lindström's views; but as they do not appear to have done so, it is necessary that I should criticize them seriatim, taking the opportunity, however, to point out the valuable parts of the Professor's communication.

1. Lindström makes the interesting discovery of the presence of the variety *borealis*, nobis, of *Caryophyllia clavus*, Scacchi, as far south as lat. $48^{\circ} 19'$, in 109 fathoms. Hitherto it had only been known as a North-Atlantic and Mediterranean form. He gave the first locality beyond its supposed home for this variety, which now has been found by Moseley in the Patagonian area.

2. I described *Caryophyllia Pourtalesi*, dredged from deep water in the North Atlantic*. Professor Lindström says:—"This coral cannot properly be classified with the genus *Caryophyllia*, as there are no regular pali, and all such are entirely wanting in the North-Atlantic specimen (*i. e.* Lindström's). But my material is too scanty to decide the question." He places *Paracyathus thulensis*, Gosse, as a synonym.

My material was not scanty, and the species was minutely described and the small columella and the irregular pali were noticed. In an essay on the 'Porcupine' *Madreporaria* (part 2), which I read before the Zoological Society a few months after Prof. Lindström read his, I gave abundant evidence of the existence of pali in the species; and Euxleben's drawings clearly indicate them†. The number of pali is small, and they are especially visible when the columella is

* "Madreporaria dredged during the Expeditions of H.M.S. 'Porcupine,'" Trans. Zool. Soc. vol. viii. pt. 5, p. 317, pl. xli. figs. 3-10.

† Trans. Zool. Soc. vol. x. pt. 5, p. 238, pl. xliii. figs. 1-7. Read May 1876, published 1878. Illustr. Cat. Mus. Comp. Zool. Harvard.—No. 1V. "Deep-sea Corals," 1871, p. 12, pl. iii. figs. 1, 2, 3.

small. They are thin and long, and are placed before the third cycle when the fourth and fifth orders are complete. They follow the law, which certainly has a meaning and classificatory value, that pali do not exist in relation to incomplete septal cycles. There is nothing present which can confound my form with Gosse's *Paracyathus*; and therefore I hold that the species I established from a considerable number of specimens, and which was considered doubtful by Lindström after the examination of one coral (which probably was not of the species at all), is a true member of the *Caryophyllia* group, and should retain the name I gave it.

3. *Leptocyathus Stimpsoni*, Pourtalès.—This coral, so interesting from its being associated with a fossil genus, was described by Pourtalès in 1871; he had some doubt about the denticulate septa taking the form out of the Turbinolidæ, but he was sure upon the point of the existence of pali (paluli), although those of the higher orders were not very distinguishable from the columellar processes. Lindström states, "There are no paluli, and the papillæ which compose the columella may sometimes be mistaken for paluli. The species, as well as the following (*Leptocyathus? halianthus*, Lindst.), cannot be classed with the *Leptocyathi* in the sense of Milne-Edwards and Haime."

This criticism was answered by Pourtalès in the Report on the 'Blake' Corals*. He wrote, "Mr. Lindström doubts the propriety of referring these corals to the genus *Leptocyathus*, although he adopts the genus provisionally. He did not recognize the pali, which, however, I find quite distinct in large specimens in front of the tertiaries; but I have had no opportunity of direct comparison with the fossil species." Prof. Lindström is wrong, as he might have expected he would be found to be, for Pourtalès was a most careful observer. I have two small specimens, one of which certainly is Pourtalès's type, for he sent it to me named. It has pali easily recognizable and before all the septa, except those of the last order. The beautiful type of the genus from the London Clay† and the equally elegant form described from the Gault‡ have pali before all the septa, and the principal costæ are produced so as to give an appearance like Moseley's discoid *Stephanotrochus*§.

Portalès's species comes into relation with an Eocene form

* Bull. Mus. Comp. Zool. Harvard, no. 9, ii. p. 201.

† Palæont. Soc. Lond., Brit. Foss. Corals, 1850, p. 21.

‡ Palæont. Soc. Lond., Brit. Foss. Corals, Supplement, pt. ii. no. 2, p. 34 (1870).

§ Report on 'Challenger' Corals, pl. iii. fig. 5.

from Sind (*Leptocyathus epithecata* *), and with the discoid *Trochocyathi* from the Cainozoic of Australia †.

Lindström describes "*Leptocyathus? halianthus*" (*op. cit.* p. 9, pl. i. fig. 9), and states that "this species is only provisionally to be ranged in the genus *Leptocyathus*, as there seems to be a great discrepancy in the arrangement of the secondary and tertiary septa, which do not unite in the previously known species." The form is largely fixed, with a broad basis; the costæ are warty and spinulose. The septa in six cycles, each containing primaries, secondaries, tertiaries, and septa of the fourth and fifth orders. Lindström states that the tertiaries are united at their "base" with the septa of the second order, and, again, those of the fourth and fifth orders are united with those of the third. But in the very clear drawing the septa of the fourth and fifth orders are straight, and do not unite with those of the third order. Which is correct, the drawing or the description? One must be wrong. The tertiary septa do unite with the secondary.

Prof. Lindström is quite correct in remarking that union of the tertiary and secondary septa has not been noticed in the previously described species. In the Tertiary species of England and Sind and in the species from the Gault there is no such union. But it is hardly a generic character. The only distinction between *Leptocyathus*, Edw. & H., and discoid *Trochocyathi* is the presence of pali before the higher orders in the first-named. This can no longer be admitted to be of generic value, and the genus must be absorbed in *Trochocyathus*.

What is the classificatory position of this doubtful form described by Lindström? Either there are pali or there are none; and the describer states that the slender styliform angular papillæ of the columella *encroaching on the basis of the septa* form, as it were, a semblance of paluli (pali). The basis means, according to Lindström, the axial end of the septum.

Admitting that there are no pali, the calice strongly resembles that of *Sabinotrochus apertus*, nobis ‡; and if the larger septa had been prolonged, the identity of the forms could hardly be doubted so far as the calice is concerned. Unfortunately Lindström does not say any thing about the number and arrangement of the costæ. If there are pali, the species must come within the genus *Trochocyathus*.

* Palæont. Indica, ser. xiv., Foss. Corals of Sind, p. 60 (1880).

† Quart. Journ. Geol. Soc. vol. xxvi. p. 296 (1870).

‡ Duncan, "Deep-sea Corals," Trans. Zool. Soc. vol. viii. pt. 5, p. 320, pl. xli.

4. *Deltocyathus Agassizi*, Pourtalès.—Lindström retains the modern name for this species, which has been exhaustively examined by Pourtalès and Moseley, and to the consideration of which I have given some care. Pourtalès sent me a specimen, and I recognized it as the well-known species *Deltocyathus italicus*, Michelotti sp., of the Tortona and other Italian Miocene deposits. Since then Pourtalès has acknowledged the fact*, and Moseley gives the proper name to the species in his "Report on the 'Challenger' Corals," p. 145, in which he quotes the final decision of the lamented naturalist. It is a most variable species, and has a wide geographical distribution.

Lindström considers some East-Atlantic specimens which have small paluli, an attached base, and thin walls to bring *Sabinotrochus apertus*, Duncan, within the species *Deltocyathus Agassizi*. Moseley spared me the trouble of answering this most extraordinary conclusion†:—"After comparing Prof. Martin Duncan's specimen of *Sabinotrochus apertus* with the series of *Deltocyathus*, I conclude that Prof. Lindström's conjecture that it is a variety of *Deltocyathus Agassizi* cannot be upheld. *Sabinotrochus* differs in its general texture and in the thickness of its septa, in its fine wavy costæ, and in the margin of the calicle being indented, also in the complete absence of pali, which are certainly not broken away."

Sabinotrochus and *Deltocyathus* are two perfectly distinct genera, and do not belong to the same group, even of the Turbinolidæ. Certainly Prof. Lindström's critical method is the reverse of complimentary, and we do not want conjectures.

Next Prof. Lindström considers that a form described by Pourtalès (*Trochocyathus Rawsoni*) "may perhaps also belong to this species (*Deltocyathus Agassizi*=*D. italicus*), being provided with septa and columella of the same shape" (p. 10). Pourtalès photographed the type of his species in pl. vi. figs. 7-10, of "Zoological Results of 'Haslar' Expedition"‡. Certainly the costæ and pali of *Trochocyathus Rawsoni* remove it entirely from *Deltocyathus*. It is a true *Trochocyathus*, allied to all forms with the tertiaries uniting to the secondaries. After seeing Lindström's criticism, Pourtalès still retained the form in the genus *Trochocyathus*, and considered that it was not without its affinities with *Paracyathus*.

Lindström compensates, however, for his unfortunate zoolo-

* "Report on 'Blake' Dredging Expedition," Corals, by Pourtalès, 1878-79, p. 101.

† Moseley, *op. cit.* p. 146.

‡ Ill. Cat. Mus. Comp. Zool. Harvard, no. 8 (1874).

gical criticisms by giving the following interesting result of his examination of young specimens of *Deltocyathus italicus* *:—"In the smallest specimen I have seen, of only 0·7 millim., there are four septa of the first order, towards which two of the second order are growing, and with these again the smaller belonging to the third order unite. But to judge by a specimen which is a little bigger (1·5 millim.) and has six regular septa of the first order, the law of substitution as expressed by Lacaze-Duthiers (Arch. de Zool. Expér. t. i. p. 368) comes into play; and of the six apparently primary septa four may have been developed out of secondary ones, only two of the original four resting in their original position as septa of the first order, the other two being, as it were, pushed aside and degraded into secondary ones." Nevertheless it must not be imagined that this arrangement is universal in the genus, for in the specimens in my possession the regularity of the appearance of six primaries and the succession of six secondaries is clear, and it is confirmed by the study of the costæ. The term "phenomenon of substitution" is much more correct than the term "law."

5. *Flabellum laciniatum*, Philippi, sp.—Lindström recognizes amongst the Josephine dredgings the common North-Atlantic *Flabellum*, which Sars had called *Ulocyathus arcticus*. But he confounds with it *Flabellum alabastrum*, Moseley—a conclusion which is refuted by that author in his "Report on the 'Challenger' Corals," with which I agree.

6. *Duncania barbadensis*, Pourtalès.—Lindström makes some valuable remarks upon this species, and notices the sameness of the septa, except those which are in relation to pali. He states that the material which fills up the calice from its base is stereoplasma, or a secretion of the basal membrane superseding or supplementing the dissepiment. He gives the only comprehensible drawing of the calice we have, and states that he has found six septa near the base. I found in a *Gwynia* a tetrameral arrangement of septa above, but a hexameral one at the base.

Portalès states that *Haplophyllia*, which comes close to *Duncania*, has the soft parts similar to this last. At present these genera, I consider, must be associated with *Gwynia*, nobis, in a group in the Turbinolidæ, and not with the Rugosa.

7. *Schizocyathus fissilis*, Pourtalès.—Lindström obtained the specimens he described from Anguilla, Salt Island, and the Josephine Bank, in from 200 to 790 fathoms. He describes an epitheca, which is not to be distinguished from

* *Op. cit.* p. 11.

the wall, and Pourtalès distinctly denies the existence of an epitheca. Lindström's drawing of a calice does not correspond in a very important character with the photograph of Pourtalès. There are no septa in Lindström's figure (pl. ii. fig. 27) in the position of the primaries of Pourtalès, and what are marked primaries by Lindström are the secondaries of Pourtalès. Lindström, however, states that there are six primaries, twelve secondaries, and six tertiaries. The coral is most carefully described by our author, and the discrepancies are perfectly incomprehensible and inexplicable. Nothing can be more interesting to zoophytologists than Lindström's remarks on the stereoplasma of this coral, on the prolongation of the ornamental granules to form false synapticula, and on the nature of the septum.

Lindström combats the teaching of Milne-Edwards and Jules Haime that each septum consists of two laminæ. He believes that the dark irregular central line seen in sections is the primary condition, and that the thick calcareous substance on either side is superadded—that really three and not two structural elements exist. He candidly admits that the two laminæ are to be seen in some fossils. They are visible enough in many recent forms; and in some Australian fossil forms where the costa does not correspond with the septal end, and this is continuous with the intercostal median line, the line which separates the septal laminæ is singularly distinct. In investigating this matter I find that the centre of the recent septum has more connective tissue than the laminæ on either side; and this can be well made out by treatment with acid—the ultimate microscopical structures radiate often from the central plane. That Lindström is right about the central line being anterior to the rest is beyond a doubt, but I do not find that it was a lamina for all that.

The splitting of the parent by an internal bud, noticed probably in the first instance by Savile Kent in a *Flabellum*, does not appear to be the phenomenon observed in *Schizocyathus* according to Lindström. He points out that "it is not a gemmation, but an interrupted and then continued growth of the same individual." He instances similar processes of growth in *Flabellum laciniatum* and *Diastrea crista*. Now Pourtalès states that the budding takes place on the secondary septa in the calice; and it must be confessed that although Lindström's figure (pl. iii. fig. 29) looks like what has recently been called rejuvenescence, and has been known for a generation as growth after arrest, the appearance of figs. 28, 30, and 31 favours the opinion of Pourtalès.

8. *Stenocyathus vermiformis*, Pourt.—Lindström and Pourtalès differ so much in their description of the appearance and morphology of this coral that it is hardly conceivable that they are treating of the same species. The species was described and delineated by Pourtalès in his 'Deep-sea Corals' (1871, p. 10, pls. i. & iii.). It is a very elongated and cylindrical form, with a shallow circular calice, septa not exsert, rather thick, and in six systems of three cycles. Pali thick, curled, and in front of the secondary septa. Columella of a single twisted process. Costæ indicated by lines of very flat tubercles. The older parts of the corallum are nearly filled up by a thickening of the septa; but the process is never carried out to a total obliteration of the interseptal chambers, which can be traced in the shape of slender canals to the very base. The costal tubercles are hollow and communicate through narrow canals with the interseptal chambers. Pourtalès considered that "these little cavities are, no doubt, homologous with hollow roots of *Rhizotrochus*, *Thecocyathus*, and other genera of the family." The height of the type was from 25 to 40 millim. and the diameter only 2 or 3 millim.

In the generic diagnosis it is stated that there is no epitheca.

The corals considered to belong to this species by Prof. Lindström never assume the vermiform shape!!! and are of a regular turbinate growth. In fact the diameter of the calice is one half of the length of the corallum. There are no tubercles as described by Pourtalès, and the dots "can in no way be considered as homologous to the rootlets in *Rhizotrochus*, *Thecocyathus*, and several other corals." In Prof. Lindström's corals there is a dense network of dissepiments which are developed out of the spines or tubercles on the lateral surfaces of the septa.

In the description of the corals dredged in the 'Blake' expedition Pourtalès contents himself with remarking:—"I cannot find in my specimens the dissepiments mentioned by Mr. Lindström."

Portalès gave me a specimen of this curious species, which tallies with his description, and not in the least with Prof. Lindström's. It is only necessary to remark that the so-called dissepiments are not what are usually called such, and that they certainly are not synaptical, which are structures independent of ornamentation.

Probably Prof. Lindström's very hasty criticism was bestowed upon a totally different species from that recognized as *Stenocyathus vermiformis*, Pourt.

It must be observed that there is an epitheca in every specimen.

much trouble, and he illustrated it several times, and stated that the edges of the septa send out trabecules, uniting together to form a rudimentary columella, which is, however, frequently absent (1871). In 1874 the same author described a new genus *Cænosmilia*, and noticed it as a genus formed to receive the *Parasmilia* propagating by gemination, and thus becoming compound. Single corals are typical *Parasmilia* with a well-developed spongy columella.

Prof. Lindström does good service in explaining that the gemination in both these instances is not from within, but that buds have attached themselves accidentally to the surface of the old form; and in the 'Blake' corals Pourtalès (p. 109) states that his alcoholic specimens show that the young one is upon a dead old one. These are therefore clearly not budding corals in the proper sense.

10. *Paracyathus arcuatus*, Lindst.—This species Pourtalès has shown to belong to the genus *Asterosmilia*, nobis, and to be the species *Asterosmilia prolifera*, Pourt. ('Blake' Corals, p. 109).

Conclusion.

1. *Caryophyllia Pourtalesi*, nobis, belongs to the *Caryophyllia*, and is a good species.

2. *Leptocyathus Stimpsoni*, Pourtalès, was perfectly drawn and described by Pourtalès, who noted the pali which Lindström missed. But neither the species nor my *Leptocyathus endothecata* of Sind can remain in the genus, which is worthless: they are discoid *Trochocyathi*. Prof. Lindström's *Leptocyathus*? is of doubtful position.

3. *Deltocyathus italicus* is the correct name for *D. Agassizi* according to Pourtalès and myself. *Sabinotrochus apertus*, nobis, is, according to Moseley, a correctly named species, and is altogether different from a *Deltocyathus* seen by Prof. Lindström. *Trochocyathus Rawsoni*, Pourtalès, is correctly placed, and Prof. Lindström is in error.

4. As Moseley has already pointed out, Prof. Lindström is wrong in confounding *Flabellum alabastrum*, Moseley, with *Flabellum laciniatum*.

5. *Haplophyllia*, *Duncania*, and *Gwynia* must be removed from the *Rugosa*.

6. The descriptions of Pourtalès and Lindström regarding *Schizocyathus fissilis* are not reconcilable.

7. *Stenocyathus vermiformis*, Pourtalès, has not the structures recognized by Lindström.

8. Lindström's observations on the budding of *Cælosmilia fecunda*, Pourt., are very good and useful.

9. *Paracyathus arcuatus*, Lindst., is *Asterosmilia prolifera*, Pourtalès.

XLIII.—*Notices of British Fungi*. By the Rev. M. J. BERKELEY, F.R.S., and C. E. BROOME, Esq., F.L.S.

[Continued from ser. 5, vol. ix. p. 183.]

1989. **Agaricus* (*Lepiota*) *limophorus*, B. & Br. Linn. Soc. Journ. xi. p. 500.

This was before recorded as a possible variety of *A. cepæstipes*; but as the species is published by Gillet under the name of *Lepiota flammula*, we think it right to give it its proper name.

We observe in Gillet's book the following synonyms, of which the indication may be useful to other fungologists:—

Ananita inaurata=*Ag. strangulatus*=*A. Ceciliae*, Berk.

Clitocybe Pelletieri=*Psallus leptopus*, Fr.

Hygrophorus amœnus=*H. calpytræformis*, Fr.

Clitocybe foetidissima=*Ag. inamœnus*, Fr.

Polvaria pusio=*Ag. temperatus*, B. & Br.

Murasmus erythropus=*Ag. cohærens*, P.

Coprinus evanidus=*C. filiformis*, B. & Br.

Pleuropus glandulosus=*Ag. ostreatus*, Jacq.

Nolanea picea=*Ag. cucumis*, P.

1990. *A.* (*Lepiota*) *illinitus*, Fr. Hym. Eur. p. 39.

Penzance, J. Ralfs.

1991. *A.* (*Tricholoma*) *oreinus*, Fr. Syst. Myc. p. 52; Cooke, tab. 218 *b*.

King's Cliffe.

1992. *A.* (*Tricholoma*) *atrocinereus*, Pers. Syn. p. 348; Cooke, tab. 52 *a*.

Hothorpe, Norths., Miss Ruth Berkeley.

1993. *A.* (*Clitocybe*) *cyanophœus*, Fr. Hym. Eur. p. 82, var. *Pengellei*, minor, B. & Br., Cooke, tab. 264.

Cornwall, T. W. Pengelly, Esq. It is possible that this form may be specifically distinct; but though it differs so much from the figure given by Gonner and Rabenhorst, the characters answer so well to those which are given in Hym. Eur. that we do not consider it at present distinct. It occurred on two occasions; the abrupt white apex of the stem is very remarkable.

1994. *A.* (*Clitocybe*) *rivulosus*, Pers. Syn. p. 369.

Var. *neptuneus*, Batsch, f. 115.

On dry mountain-pastures near the sea, Llandulas, Miss Ruth Berkeley.

LACCARIA, n. g.

Contextus tenax; hymenium cum stipite confluent; lamellæ crassæ sporis globosis pulverulentæ.

This is clearly quite as distinct from the genus *Agaricus* as *Russula* and *Lactarius*, and cannot with any justice be included in the subgenus *Ulitocybe*. We have several very distinct forms from Ceylon, besides our own *A. laccatus*, *bellus*, and one or two continental species. The amethyst-coloured form usually referred to *A. laccatus* is probably distinct. We have long seen the necessity of this separation, but were unwilling to add to the numerous genera already separated from *Agaricus*, with greater or less reason.

1995. *A. (Collybia) adematopus*, Schæff. t. 259.

Glamis, Rev. J. Stevenson. The specimens were, however, in a very early stage, and the identification requires confirmation; they, however, exhibit all the characters of the species or subspecies as recorded by Fries, Hym. Eur. p. 112.

1996. *A. (Collybia) ozes*, Fr. Hym. Eur. p. 125.

Hothorpe, Norths., Feb. 18, 1882, Miss R. Berkeley. Scent strong, the gills cinereous, veined.

**A. (Mycena) marginellus*, Fr. Myc. Eur. p. 131.

Coed Coch, Miss R. Berkeley. Sibbertoft. *A. marginellus*, Quélet, is clearly different. The campanulate pileus is distinctive.

1997. *A. (Mycena) metatus*, Fr., Cooke, tab. 238.

On mossy ground. Penzance, J. Ralfs.

1998. *A. (Mycena) pullatus*, B. & Cooke, tab. 237.

With the last, Penzance.

A distinct species, of which the description will be given by Dr. Cooke.

1999. *A. (Omphalia) telmaticus*, Cooke, tab. 240.

On *Sphagnum*. This is our *A. affricatus*, which appears not to be the plant of Fries.

2000. *A. (Pleurotus) acerinus*, Fr. Hym. Myc. p. 175.

On ash, near Morpeth, C. H. Sp. Perceval, Esq.

2001. *A. (Pleurotus) limpidus*, Fr. Myc. Eur. p. 177.

On decaying wood, Penzance, J. Ralfs. Cheshire, A. Walker, Esq.

2002. *A. (Pleurotus) hypnophilus*, Fr. Myc. Eur. p. 181.

On moss in wood, Coed Coch.

2003. *A. (Leptonia) asprellus*, Fr. Myc. Eur. p. 205.

Amongst grass, Coed Coch.

2004. *A. (Eccilia) griseo-rubellus*, Fr. Hym. Eur. p. 212.

Sibbertoft, Miss Ruth Berkeley.

**A. (Hebeloma) fastibilis*, Fr. Hym. Eur. p. 237.

A very perfect form of this very variable species occurred at Coed Coch, Oct. 1883, in which there was a distinct membranous ring, and above the viscid coat of the pileus there was a circle of distinct floccose scales.

2005. *A.* (*Hebeloma*) *magnimamma*, Fr. Hym. Eur. p. 243.

Sibbertoft. Amongst grass under apple-trees.

**A. tener*, Schæff., var. *pubescens*.

Coed Coch.

According to Fries this is *A. pilosellus*; Pers.

2005 bis. *A.* (*Tubaria*) *stagninus*, Fr. l. c. p. 273.

Sibbertoft, in marshy ground. A dwarf form about the size of *A. inquilinus*.

2006. *A.* (*Crepidotus*) *applanatus*, Pers. Obs. i. p. 8.

On decaying wood, Penzance, J. Ralfs.

2007. *A.* (*Crepidotus*) *haustellaris*, Fr. Hym. Eur. p. 276.

With the last. Penzance, J. Ralfs.

2008. *A.* (*Crepidotus*) *Ralfsii*, B. & Br. Pileo semireflexo luteo, subtiliter furfuraceo hispidulo, margine involuto patulo, floccis gossipinis affixo, stipite obsoleto, lamellis ventricosus argillaceis, margine albedo.

On decaying wood. Penzance, T. W. Pengelly, Esq.

2009. *A.* (*Psilocybe*) *subericæus*, Fr. Icones; *A. clivularum*, Let.

Near Chester, A. O. Walker, Esq. This is probably a common species. We have found it many years since at King's Cliffe. *A. clivularum* is referred by Fries to his *A. ericæus*, but it is clearly rather his *A. subericæus*.

2010. *A.* (*Psathyra*) *conopileus*, Fr. Hym. Eur. p. 304.

In various places amongst grass and in garden borders, varying when fresh in the depth of the brown tint. Near Peterborough it occurred last year with a distinct bulb.

2011. *A.* (*Psathyra*) *glareosa*, B. & Br. Pileo campanulato obtuso l. umbonato griseo apice pallide castaneo striato miculato-floccoso; stipite fistuloso fibrillis albis vestito, brunneo, lamellis late adnatis umbrinis.

On gravelly soil after wet weather, Sibbertoft, June 7, 1882.

Pileus half-inch across, very minutely tomentose; stem 1-2 inches high, 1 line thick; gills broad behind, adnate, spores black. Flesh brown, especially close to the gills.

2012. *A.* (*Psathyra*) *pellospermus*, Bull. tab. 561.

We have certainly had this year the true plant of Bulliard, which seems to us distinct from *A. corrugis*.

2013. *A.* (*Psathyrella*) *crenatus*, Fr. Hym. Eur. p. 315.

Penzance, J. Ralfs.

2014. *Coprinus flocculosus*, Fr. Hym. Eur. p. 323.

King's Cliffe.

2015. *C. cothurnatus*, Godey, in Gillet, Planches Supplémentaires.

Penzance, J. Ralfs.

2016. *Cortinarius* (Telamonia) *scutulatus*, Fr. Hym. Eur. p. 377.

Sibbertoft. The form figured by Quélet, not that by Fries in the 'Icones.'

2017. *C.* (Telamonia) *stemmaus*, Fr. Hym. Eur. p. 385.

Lyne, Sussex, Miss Broadwood. The ringless form mentioned by Fries in the text.

2018. *C.* (Hygrocybe) *germanus*, Fr. Hym. Eur. p. 397.

Coed Coch, A. O. Walker, Esq.

2019. *Hygrophorus glutinifer*, Fr. Hym. Eur. p. 408.

Penzance, J. Ralfs. Probably the same with the little-known *Ag. aromaticus*, Sow.

2020. *H. vitellinus*, Fr. Hym. Eur. p. 417.

Penzance, J. Ralfs.

2021. *Lactarius hysginus*, Fr. Hym. Eur. p. 426.

Near Morpeth, C. H. Sp. Perceval, Esq.

2022. *Lentinus lepideus*, Fr. Hym. Eur. p. 481.

In an old hollow elm, C. J. Plowright, Esq. The veil still adhering to the edge of the pileus. Specimens found before in this country have been on imported pine-wood. The proper name is "*lapideus*," "*lepideus*" inaccurately.

2023. *Polyporus* (Pleuropus) *petaloides*, Fr. Hym. Eur. p. 536.

Sibbertoft. A single specimen on an old stump, Rev. W. Gregson.

A very interesting addition to our mycology, and of great beauty.

**P.* (Placodermi) *fomentarius*.

Var. *pomaceus*, Pers. Syn. p. 531. J. Ralfs.

The common form on willow, which is very hard, occurs also in Cornwall. This, however, is referred by Fries to *P. igniarius*, the true distinction of which species depends on the difference of the colour of the spores, which are dark and ferruginous, and not white, as in *P. dryadeus* and *P. igniarius*.

2024. *P.* (Inodermei) *gossypinus*, Fr. Hym. Eur. p. 566.

On an old stump of *Ulex*, Sibbertoft. Distinguished at once by its dædaleoid pores. We hoped to get a large supply of specimens this year; but the same stump, which was accidentally trodden down, has produced instead *P. fumosus* in great abundance.

2025. *P.* (Resupinati) *Læstadii*, Fr. & Berk. Contextu albo, poris læte citrinis hymenio, hic illic tuberculato.

On the underside of a deal board in a hothouse. Coed Coch.

Colour bright persistent yellow; very beautiful.

We have no doubt that our plant is what is mentioned by Fries, Hym. Eur. p. 575. It forms confluent patches many inches in length.

2026. *Stereum rubiginosum*, Fr. Hym. Eur. p. 641.

On decaying wood, Penzance, J. Ralfs. A very different species from *S. tabacinum*.

2027. *S. stratosum*, B. & Br. Effusum, late ochraceo-album glabrum lutescens hic illic rugosum, contextu pallido stratoso, stratis demum solutis.

Penzance, J. Ralfs.

At no. 1962 for "*Marasmius*" read "*Hygrophorus*." We are glad of this opportunity of correcting an unfortunate error, as this is, in all probability, the last of a long series of notices.

XLIV.—*Mochlonyx* (Tipula) *culiciformis*, De Geer.

By F. MEINERT*.

IN the year 1776 De Geer, in his 'Mémoires pour servir à l'histoire des Insectes' (tome vi. p. 372), described the development of a small midge or gnat, *Tipula culiciformis*, and gave (on pl. xxiii. figs. 3-12) figures of the larva and pupa and of the male imago. De Geer had found the larva in the month of May in pools and swamps ("des étangs et des marais") and successfully bred them; but since that time no one seems to have met with the larva, indeed the imago itself seems not to be known, and some doubt has arisen as to the correctness of the developmental history given by De Geer, notwithstanding that author expressly states that he had reared both pupa and imago. In the months of April and May of last year (1882) I was fortunate enough to capture the larva in various places in this neighbourhood and to rear the gnat, by which means it appeared that De Geer's description was exactly in accordance with the truth. At present, however, I shall confine myself to describing the imago itself and indicating its place in the system, reserving the description of the larva and pupa for a general working up of the great number of midge and gnat larvæ upon which I have been at work for a long time, and which I hope to have ready in the course of the present year.

* Translated by W. S. Dallas, F.L.S., from the 'Oversigt af Konglige Danske Videnskabernes Selskabs Forhandlingar,' 1883, no. 1, pp 1-17.

De Geer seems only to have known the male, as he only describes and figures that sex; but unfortunately the description is very incomplete, and the figures are not much better. Nevertheless upon this description and these figures a distinct genus, *Corethra*, was afterwards established, and for this genus De Geer's species was thus the type. Subsequently other small flies were also either transferred to the genus *Corethra* (such as *Tipula plumicornis*, Fab., which, under the name of "*Corethra plumicornis*," is one of the best-known and most frequently examined insects) or established as new species of *Corethra* (such as *C. pallida*); but until now no one seems to have found De Geer's gnat, unless the *Corethra velutina*, described by Ruthe in the 'Isis' for 1831, should be identical with De Geer's *Tipula culiciformis**, which, however, is not probable.

De Geer's diagnosis of the imago runs as follows:—"Tipule brune, à antennes filiformes en plumes dans le mâle, à ventre et pattes grises, et dont les nervures des ailes sont velues." "*Tipula (culiciformis) fusca*, antennis filiformibus maris plumosis, abdomine pedibusque griseis, costis alarum hirtis." In conclusion he gives (*l. c.* p. 378) a fuller description of the imago; but in this he adds nothing to what he gives in the diagnosis or what can be seen in the figures (figs. 11 and 12), except that the antennæ are stated to be black.

In the "Versuch einer neuen Gattungs-Eintheilung der europäischen zweiflügeligen Insekten, von Joh. Wilh. Meigen," which Illiger published in his 'Magazin für Insektenkunde' (Bd. ii. pp. 259-281, 1803), Meigen established the genus *Corethra*, and cited as the single or typical species of that genus *Tipula culiciformis*, De Geer (*l. c.* p. 260). Also in

* For synonymic purposes Walker's *Mochlonyx effatus* ('Insecta Britannica,' Diptera, iii. p. 252) and Gimmerthal's *Corethra pilipes* (Bull. Moscou, ii. p. 287), as well as Van der Wulp's *Corethra obscuripes* (Tijdschr. Entom. Nederl. Voreen, ii. p. 160), should be examined; but this was impossible for me, and I doubt whether others will gain much advantage by it.

[It is to be remarked that Walker, or rather Haliday, the real authority for this part of the 'Insecta Britannica,' not only describes *Mochlonyx effatus*, as above cited, but also cites De Geer's *Tipula culiciformis* as a species of *Corethra*. He describes both sexes of the latter, and notices the species as "not generally common, but sometimes appearing in great profusion." He describes the antennæ in *Corethra* as fourteen-jointed, and those of *Mochlonyx* as sixteen-jointed; but the figure of the male antenna of *M. velutinus* shows only fifteen joints. On the other hand, Meiner's figures which accompany the present paper in the Danish original show the male antennæ of fifteen, and those of the female of fourteen joints, although from his description the number would appear to be the same in both sexes.—W. S. D.]

his classical work, 'Systematische Beschreibung der bekannten europäischen zweiflügeligen Insekten' (1818, Th. i.), Meigen left the insect in the same systematic position (*l. c.* p. 16); but here he states that he had not seen the animal, for which he reproduces De Geer's diagnosis, which, after generic characters were cut out, comes to run as follows in the Latin translation:—"Fusca, abdomine pedibusque griseis."

Henceforward De Geer's *Tipula culiciformis* bears the generic name *Corethra*, and under the denomination of *Corethra culiciformis* we meet with it both in general manuals, such as Cuvier's 'Règne Animal' (ed. ii. 1829, tome v. p. 441), where this species alone is named in the genus *Corethra*, and in special entomological systems and text-books, as in Latreille's 'Genera Crustaceorum et Insectorum' (tome iv. 1809, p. 247), where *C. culiciformis*, Meigen, is cited, with a reference to De Geer, as the type species, while Réaumur's and Slabber's *Tipularia* (= *C. plumicornis*) are referred to it with some doubt ("pertinere videntur"). In Kirby and Spence's 'Introduction to Entomology' (vol. ii. 1817, p. 322, German translation), in Westwood's 'Introduction to the Modern Classification of Insects' (vol. ii. 1840, p. 515), and in the regular systematic and faunistic works on the Diptera also, *Corethra culiciformis* is named again and again; nay we even find a detailed description and figures of a species so named. It is Lehmann* who has described and figured a male *Corethra* as the *C. culiciformis* cited but not seen by Meigen. It is not, however, De Geer's *Tipula culiciformis* that he describes, but probably the *Corethra fusca* established by Stæger.

Subsequently doubts began to arise as to the correctness of the reference of *Tipula culiciformis* to *Corethra*, or more properly to *Corethra* with *Tipula plumicornis*, Fab., as its type. Stæger may be named as the first who expressed this doubt. In his "Systematisk Fortegnelse over de i Danmark hidtil fundne Diptera" (Naturh. Tidsskr. Bd. ii. 1838-39, p. 556) he established a new species, *Corethra fusca*, and referred to it doubtfully Meigen's and Macquart's *Corethra culiciformis* (= *Tipula culiciformis*, De Geer). He speaks as follows:—"This species may perhaps be *Corethra culiciformis*, Meig., Macq.; but the *Tipula culiciformis*, De Geer, cited by these authors, the larva of which is figured in the

* "Insectorum species nonnullæ vel novæ vel minus cognitæ, in agro Hamburgensi captæ, ex ordine Dipteriorum. Descripsit et illustravit J. G. C. Lehmann," Nova Acta Acad. Cæs. Leop. Carol. xii. (1825), pp. 29-248, tab. xv. Reprint of 'Zoologicarum præsertim in faunam Hamburgensem observationum pugillus primus' (1822), pp. 38-46.

form of a *Culex* larva, may be different." As we see here, it is the larval form of *C. culiciformis*, and the great difference that exists between this larva and the larva of another species of the same genus, *C. plumicornis*, Fab., long previously described and figured by Réaumur, Goetze, Slabber, Lehmann, Goring, and Lyonnet, that called forth in Stæger this exceedingly justifiable doubt as to the correctness of the synonym. Besides the doubt came the more home to Stæger, or was the more justified in him, as he had reared his new species, *Corethra fusca*, from a larva which certainly differed in two essential structural characters from the larva of *C. plumicornis*, but the differences of which are confined within probable limits. But that the differences were far from being so great as Stæger believed, and especially that the larva comes much nearer to the larva of *Corethra* than to those of *Culex*, nay, that the newly discovered larva of *Corethra fusca* in its most essential differences from the larva of *Corethra plumicornis*, namely the cleft setæ in the tail- and swimming-fins, agrees with De Geer's larva, Stæger could not well see—in any case he did not take it into consideration; and he had not, any more than any one else since De Geer, himself seen the larva of "*Tipula culiciformis*." It was the external resemblance in habit to *Culex*-larvæ which had already struck De Geer, and perhaps also especially the posterior breathing-tube that had raised doubts in Stæger. The same doubts, moreover, were expressed soon after by Westwood in his 'Introduction' (l. c. p. 515), who says, "I fear there must have been some errors either in De Geer's observation or in Latreille's synonym, inasmuch as Réaumur's figures of the transformations of a species described as *Corethra plumicornis* totally differ from De Geer's."

Zetterstedt, in the 'Diptera Scandinaviæ' (tom. ix. 1850, pp. 3474 *et seq.*), exactly follows Stæger, and also cites Meigen's and Macquart's *C. culiciformis* with doubt under Stæger's *C. fusca*. Upon this he says, in note 1, "*Tipula culiciformis*, De Geer, ob larvam tanquam larvæ *Culicis* similem ibidem descriptam, nec 'flavicantem, hyalinam, pelucidam' (qualis larva *C. fusca* deprehensa), a D. Stæger ut a *C. fusca* diversa species habetur."

From a faunistic point of view it is very remarkable that neither Stæger, who was an industrious collector of Diptera, especially in the neighbourhood of Copenhagen, nor Zetterstedt, who, besides his own and all the Swedish collections, also received from collectors in this country, and especially from Stæger, all their Diptera for examination, should have met with *Tipula culiciformis*, or its exceedingly peculiar and easily

recognizable larval form; for in the few years that I have specially studied our midge-larvæ I have found this larva distributed from Ruderbøgn in the north, to Boserup Skov in the west, and Valle in the south; even in Dyrehave, not far from Ørdrupsmose, Stæger's favourite collecting-place, I have met with it in great abundance; and it also occurs in the collection of larvæ in the University Zoological Museum. However, it is a fact well known to collectors that many animals have certain periods during which they nearly disappear, and others in which they occur abundantly.

When we say that Zetterstedt did not know *Tipula culiciformis* as Danish or Scandinavian, it must be borne in mind, nevertheless, that in his first treatment of the genus *Corethra* (l. c. p. 3475, note 2) he remarks that Wahlberg, perhaps, was acquainted with it:—"In annotationibus mecum communicatis dixit Cel. Prof. Wahlberg, se ad Guseum Ostrogothiæ et ad Holmiam *Corethram culiciformem* invenisse. Si vero eadem ut nostra *C. fusca* aut Degeerii *C. culiciformis* sit habenda, dijudicare non possum, cum specimina Wahlbergiana cum nostris comparare non potui." It may also be noticed that in the 'Diptera Scandinaviæ,' tom. xii. seu supplementum tertium (1855), p. 4837, he cites *Corethra velutina*, Ruthe, as new for the Scandinavian fauna; for it is possible that *Tipula culiciformis* is here intended, and, in any case, it seems to me nearly certain that this species may belong to the same genus as *C. culiciformis*, as will appear from what follows.

Schiner also ('Fauna Austriaca: Die Fliegen (Diptera),' Bd. ii. 1864) did not know *Tipula culiciformis*, but simply cites it among the European species occurring outside of Austria, referring to De Geer's description in his 'Mémoires,' l. c.

But while the species thus seems to have disappeared, or not to have been met with since De Geer's time, and the genus *Corethra*, as that genus is now formulated with *C. plumicornis* as the type species, does not agree with *T. culiciformis*, another genus, *Mochlonyx*, has been established, to which it would appear that De Geer's species may fairly be referred*. The establishment of this genus took place as follows:—

* Strictly speaking, the generic name *Corethra* should be retained for *Tipula culiciformis*, De Geer; and when other species, such as *Corethra plumicornis* and *pallida*, were afterwards proved to belong to a different genus from this first-named species, a new generic name ought to have been selected for them. But I regard it as very hazardous to introduce changes of name for such a well-known species as *C. plumicornis*, which

As early as the year 1831, Ruthe, in "Einige Bemerkungen und Nachträge zu Meigen's 'Systematische Beschreibung der europäischen Zweiflügeligen Insekten,'" ('Isis,' 1831, pp. 1203-22), described a new gnat under the name of *Corethra velutina*, which he stated to be very nearly allied to *C. culiciformis*, Meig. (or rather De G.), but which, besides the colour and clothing, could be easily distinguished by the proportions of the tarsal joints, and by the structure of the last joint and the claws. He seems to have captured only a single male. Among the characters of the new species the particular statement of the very short first tarsal joint could not but strike so distinguished a dipterologist as Loew*; and in his "Beschreibungen einiger neuen Gattungen der europäischen Dipterenfauna" (Ent. Zeit. Jahrg. v., 1841) he took occasion to establish, for Ruthe's *Corethra velutina*, a new genus, *Mochlonyx*, which he characterized (l. c. p. 121, note) as follows:—"Mochlonyx, M., a genus coming next to *Corethra*, which, among other things, is very easily distinguished from the latter by its first tarsal joint being very short, namely, one fourth the length of the second, the fifth of the same structure as in *Liponeura*, and the claws bifid at the apex, and furnished at the base with a downwardly directed process (vid. tab. i. fig. 11)." The figure cited gives a rather rough representation of the last tarsal joint with the claws. The character of *Mochlonyx* here given may certainly be regarded as stating the chief differences as compared with the nearly allied genus *Corethra*; but besides that it is too scanty, and therefore insufficient to give a zoological image of the new generic form, it has the further great imperfection that it is made solely from the male, and that the character taken from the structure of the last claw-joint with the claws, which alone are figured, does not apply to the female, which has far simpler claw-joints and claws. For in this genus we find the unusual case that the sexes differ not only in the usual way in the structure of the antennæ, head (including the mouth parts), and the generative organs, but that also the claw-joints and the claws differ according to the sex.

bears one of the best-known of zoological names, and the larva of which has acquired a classical reputation as the object of histological investigations. If such a change is eventually to be made, it had better remain over for some future monograph of this group. [See also note p. 375. -W.S.D.]

* Zetterstedt, who also, in his third supplement, has Ruthe's species, *Corethra velutina*, from Öland, makes no remark upon this character, but seems not to have been acquainted with Loew's article here cited, although it had appeared eleven years before.

Schiner, in his 'Fauna Austriaca' (p. 622), adopts the genus *Mochlonyx*, and gives, from individuals which he obtained from Loew, a description of it, drawn up with constant references to *Corethra* and in his usual pattern of generic descriptions; but we learn nothing new from it.

From all this I think that a complete description both of the genus in its two sexes and of De Geer's so long misunderstood species, *Tipula culiciformis*, will not be out of place. . . . From this it will appear that, although the two genera [*Mochlonyx* and *Corethra*] come very near together, especially in the female sex, there are nevertheless besides those differences between the sexes which are so characteristic of the new genus sufficient characters for the establishment of the two genera. The likeness between the imagines of the genera is the more remarkable as the difference between the larvæ and pupæ, and especially between the larvæ, is so great; but, on the other hand, there are other genera among the true Culicidæ, such as *Culex* and *Anopheles*, of which the imagines, at any rate in one sex*, are so like as to lead to confusion, while the larvæ are exceedingly different, inasmuch as some of them have and others are destitute of external breathing-tubes, therefore a difference similar to that between the larvæ of *Corethra plumicornis* and *Mochlonyx culiciformis*. Here, both with regard to the undescribed larva of *Anopheles* and the other more or less known midge-larvæ, I may refer to the great memoir upon these larvæ, which, as already stated, I shall soon be able to complete; and in the meanwhile the reader must content himself, as regards the larvæ of *Mochlonyx*, with De Geer's rather rough representation (l. c. pl. xxiii. figs. 3-9).

As it would occupy too much time and lead me too far should I establish an independent scheme of the genera of Culicidæ, and I should, moreover, run the risk of producing nothing better than we already possess, I shall here avail myself of Schiner's, as elaborated by him in his 'Fauna Austriaca,' and introduce into it various new characters.

Familia Culicidæ.

Genus MOCHLONYX.

Mochlonyx, Loew, Ent. Zeit. Stettin, Jahrg. v. p. 121, note.

Corethra, Ruthe, Zetterstedt.

Magnitudinis mediocris species figuram *Culicis* sensu strictissimo quodammodo referunt.

Caput in transversum rotundatum; proboscis producta, labrum partem dimidiam articuli tertii (secundi autt.) attingens; cultelli feminae breves, dimidiam partem scalpelli fere æquantes, membranacei, lati, angustati; scalpella labrum fere æquantia; palpi antennis maris vix duplo, aut feminae sesqui breviores, quinque-articulati, articulo ultimo quam penultimo manifesto longiore.

Antennae protrusae, quattuordecim-articulatae, articulo basali maris disciformi, feminae depresso conico, articulis obscure fusiformibus, corona setarum maris multo longiore atque densiore, articulis binis ultimis pertenuibus, longis, ultimo manifesto brevior.

Oculi magni, globosi, maris subluniformes; macula ocularis magna, discreta.

Ocelli desunt.

Scutum dorsale fornicatum, ante propendens, simplex. Scutellum parvum.

Abdomen novem-annulatum, protrusum, angustum; forceps copularis maris productus, stylo in formam cochlearis producti redacto, ad apicem aculco parvo, cultriformi instructo (infra duae laminae chitinae in uncum validiorem, liberum extus, desinunt); forceps feminae brevis, aduncus.

Pedes producti, tenues, dense hirsuti; articulus primus tarsi (metatarsus) secundo pluries brevior, articulus ultimus pedum maris ad basin tumidus setisque incurvis instructus; feminae simplex; unguis producti, graciles, ad basin breviter hirsuti atque processu longiore crenulato instructi; unguis maris praeterea ad apicem dente producto, tenui armati; onychium productum, flexuosum, pertenuis, processus multos, filiformes e lateribus emittens.

Alae productae, angustae, costis dense hirsutis, fimbria densa, duplici in margine ornatae; costa longitudinalis quinta ante costam transversalem postremam ramum superiorem, prope ad marginem admodum curvatum, emittens; cellula basalis utraque integra; cellula discoidalis deest; lobi basales alae admodum protrusae; halteres liberi.

Metamorphosis *M. culiciformis* a De Geer descripta; larvæ in aqua vitam degunt; victus rapax.

The species are of medium size or perhaps rather small, like the species of *Corethra*; in habit, although they come very near the last-named midges, they nevertheless in some respects more resemble the species of *Culex* than the true midges. Nearly the same may be said of the other genera here under consideration; the larvæ of *Culex* and *Mochlonyx* in habit come nearer to each other than the larvæ of *Mochlonyx* and *Corethra*, but the relation is reversed when we take

The *head* is rounded; the parts of the mouth with the second metamere of the head are protruded, oval; the proboscis is protruded and comparatively large. The *labrum* is elongated, narrowed, slightly arched forwards, with a pair of setæ inserted on the lower surface a little behind the apex; the dorsal plate of the first metamere (*scutum dorsale metameri primi*) is but very short, and the larger part of the labrum is therefore the posterior, and it is supported at the sides by the long thin lateral pieces (*epipharynx*), which may easily be traced back to the pharynx from which they start*. The *hypopharynx* is long, compressed, strongly pointed; it forms a deep boat-shaped channel, the anterior extremity of which runs out into two short horns, and the sides of which, on their outer margins, are furnished with a close fringe of long very fine setæ. Of the *salivary duct* I have seen no trace either in males or females. The *proboscis*, as already stated, is extended, and the basal part (*scutum ventrale metameri primi* or *mentum* aut.) is large and strongly beset with hairs. The *ligula* is long and conical. The *labella* are distinctly two-jointed, broad, rounded off in front, with their inner angles produced into a short point; no inner supporting apparatus is to be seen. The *sculpella* (*maxillæ* aut.) are tolerably long, very acute, thin, nearly membranous, and reach in length about to the middle of the labrum or halfway up the third joint of the palpus. The pleural processes or *cultelli* (*mandibulæ* aut.) as usual occur only in the females; they are a good deal shorter than the sculpella, and of a broader and more obtuse form, but likewise thin and membranous †. The

* In presence of the objection lately urged by Kræpelin (Zool. Anz. 1882, p. 576) against the opinion put forward by Menzies and defended by Dimmock and myself, that the labrum may be regarded as a fusion of two different pieces or parts, I willingly admit that the labrum presents itself as "eine einfache Ausstülpung des Kopfes;" but nevertheless I think that the epipharynx cannot be called either an "Ausstülpung" or a "Hohlraum," but only a chitinous prolongation of the upper margin of the pharynx; and it seems to me not improbable that similar chitinous processes may become amalgamated with or lodge themselves in the dorsal part of a metamere. For me therefore there can be no question of a fusion of two "Ausstülpungen" or of two "Hohlräume."

† In a morphological point of view these pleural processes are of great interest, for in *Mochlonyx* (and likewise in *Orthra*) they distinctly appear as simple processes without any trace of articulations, so that it is very difficult or impossible to assimilate them with the mandibles such as we know them in insects with biting mouth-organs (and Hymenoptera). But neither can it be denied that they correspond exactly with the organs which are known under the name of mandibles in the females of *Culex*, *Ceratopogon*, *Simulium*, and *Tabanus*, and which I have described in most of the genera or families here mentioned under the name of pleural processes or *cultelli* (cf. *Trophi*, *Dipterorum*: Fluores Mundteile).

palpi are long, thin, strongly hairy and five-jointed. There is no great difference between the absolute lengths of the palpi in the male and female, but compared with the antennæ they are to them in the males in the proportion of 1 : 2, in the females of 2 : 3. The first two joints are very short, together about half the length of the third joint; the last joint is a little longer than the penultimate. In opposition to Meigen, Zetterstedt, and Schiner, I regard the palpi as commencing with two short clavate joints, considering the constriction that occurs as sufficient to constitute a joint, although this constriction does not go round the whole circumference.

The *antennæ* are extended, rather long, in the males with very long and close, in the females with much shorter and thinner, circlets of setæ. The length of the setæ increases somewhat posteriorly, and on the last antennal joint the setæ are suddenly much shorter and fewer in number. The number of antennal joints is fourteen in both sexes; but while in the females the joints are nearly cylindrical, about equal in length, only the last joint being recognizably longer than the penultimate (about as 6 : 5), in the males the joints are fusiform in inverse proportion to their length; and further, the middle joint is distinctly shorter than the others, of which again the penultimate joint is suddenly longer than the preceding one (over twice as long) and considerably longer than the following one (about as 4 : 3). The first joint is very short and thick, especially in the male, in which it is nearly disciform.

The *eyes* are naked and occupy about half the upper surface of the head in the female, in which they are also slightly incurved; in the male they are comparatively smaller, but more strongly incurved; on the lower surface they are narrow and crescentiform. The facets are large, round, very convex. The eye-spots (*macule oculares*) are large and well separated from the eyes.

The *dorsal shield* (*scutum dorsale*) is large, very convex, slightly projecting above the head, without a transverse suture. The scutellum is small.

The *abdomen* is long, slender, slightly narrowed posteriorly, with numerous and long hairs, nine-jointed*; the penultimate segment is suddenly much shorter than the preceding, and the last segment again much shorter than the penultimate.

The external generative organs of the male are very large,

* Schiner counts eight segments in the abdomen, and this number is also given for *Corethra* by Meigen and Schiner; nay Zetterstedt even says of *Corethra* (l. c. p. 3170), "Abdomen 8-annulatum (segmenta tantum 7 numero)."

the basal joint of the forceps especially being very stout. The styles, on the contrary, are slender and slightly cochleariform, and bear at the apex, besides the very small and fine tactile setæ, a small cultriform spine. Opposed to the styles are a pair of short but strongly chitinized hooks, which are inserted into the body as broad, somewhat dilated, posteriorly rounded chitinous plates, with the posterior margin deeply emarginate. The external genitalia of the female are short and stout.

The legs are long, thin, densely hairy, and the first joint of the tarsi (*metatarsi*) is several times shorter than the second. The proportion between these two joints in the male is for the first pair of legs as 1 : 6, for the second pair as 1 : 5, and for the third pair as 1 : 4. In the female, on the other hand, the proportion for all three pairs of legs is as 1 : 5*. The second tarsal joint is always the longest of all; in the male on all the tarsi a little more than twice as long as the third; in the female on the first two pairs of legs not quite twice the length, but on the third pair rather more than twice as long. The last joint, or the claw-joint, is simple in the female, but in the male it is inflated at the base, where it bears a quantity of large incurved setæ. The claws are long and slender; in the male they are relatively longer and thinner; from the middle of their inner margin starts a large, thin, slightly bent tooth, and from their basal part a short, pretty straight, crenulated process; in the female the claws are simple, but the basal processes are comparatively longer and more strongly denticulated. The *onychium* consists of a long seta, which is somewhat thickened at its basal extremity, but produced in front into a very long, thin, somewhat bent or twisted thread, which bifurcates at the end, but before this emits from its sides rows of teeth as fine as hairs.

The wings are long and narrow, and the nervures are closely beset with short setæ arranged in pairs along them; the transverse nervures, however, are naked. The fringe of the wings consists of a double row of setæ or lance-shaped spines, of which the upper series, or those which are attached to the upper surface of the wing, are, at any rate on the posterior margin, about half as long again as the setæ in the series which is attached to the lower surface of the wing. It is in the posterior margin of the wing that these setæ attain their highest development and most strongly marked lanceolate

* Ittke gives the proportion in *Mochlonyx* (*Corethra*) *velutina* for the fore legs as barely 1 : 4 :—"das erste Glied aller Fusse viel kürzer als das zweyte und dritte, an den vorderen Füssen verhältnissmässig noch kürzer und nicht den vierten Theil des zweyten erreichend."

form, with the supports of the blades from two to three times their thickness in length; but towards the apex of the wing the lanceolate form disappears more and more, and on the anterior margin of the wing they become setæ of the ordinary form. The second and fourth longitudinal nervures are bifurcated; the fifth longitudinal nervure emits, a little before the transverse nervure, a nervure towards the margin of the wing, which, however, does not reach the latter, but runs for some space parallel to it. Both marginal cells are entire; the discoidal cell is wanting.

The development, so far as *Mochlonyx culiciformis* is concerned, is described by De Geer. The larvæ live in water, and travel in the same way as the larvæ of *Corethra*. They live by rapine, and when pressed by hunger devour each other.

With regard to the generic characters of *Corethra*, the following points may be indicated in contradistinction to *Mochlonyx* :—

Of the mouth-parts the *cultelli* (in the female) are smaller and attain only a fourth part of the length of the third joint of the palpi.

The *eyes* are more strongly sinuated than in *Mochlonyx*.

The external *genitalia* of the male are somewhat slighter, and the styles are destitute of the cultriform spine at their apex. The prehensile hooks are further much shorter, with a short inner lamella, and do not reach beyond the posterior margin of the last abdominal segment.

The *legs* present the essential generic distinction from *Mochlonyx*; but while in the latter genus they are exceedingly different according to the sexes, especially as regards the claw-joint and the claws, they are here pretty nearly alike in both sexes. In *Corethra* the proportion between the lengths of the tarsal joints is a pretty regular decrease from the first to the last joint, and the last joint, in both sexes, is normally constructed. The claws are rather long and slender, finely haired from the base to beyond the middle. The lateral processes are flat, broad, and cut at the edge into many teeth as fine as hairs. The onychium is much shorter than in *Mochlonyx*, and cleft at the apex into four long hair-like teeth.

The *wings* are a little broader and more acute, and the fourth longitudinal nervure divides rather higher up; the side-nervure emitted by the fifth longitudinal nervure is also much shorter and terminates a little before reaching the margin of the wing, but without following it. In the fringes the setæ of the lower short series are comparatively shorter; but in

this particular some specific difference prevails, the difference mentioned not being so great in *Corethra pallida*.

The *larvæ*, on the contrary, are extremely different; but it must also be pointed out that even within the genus *Corethra* there is no inconsiderable difference between the species, for according to Stæger (*l. c.* p. 556) the swimming-fans in the larvæ of his *C. fusca* do not consist of fringed setæ (as in *C. plumicornis*), but of cleft setæ (as in *Mochlonyx*).

Mochlonyx culiciformis, De Geer.

Tipula culiciformis, De Geer, Mém. pour servir à l'histoire des Insectes, tome vi. p. 372, pl. xxiii. figs. 3-12.

Fusco-brunnea, ferrugineo-pilosa, thorace linea media dorsali duplici obscura notato, metanoto nigrescente, abdomine pallido, scutis dorsalibus maximam partem dense nigro-fusco irroratis. Palpi antennæque nigro-fusca, antennis feminae late, ant. maris anguste dilute balteatis, apice setarum cinerascens. Halteres pallidi, capitulo brunnescente. Pedes dilute flavi, genibus apiceque articulorum priorum tarsalium articulisque posterioribus vel posticis totis fuscescentibus. Alæ maris fumatæ, al. feminae ante flavescentes. Long. $2\frac{1}{2}$ –3^{'''}.

The indications of colour are drawn up from old dry specimens, as required for systematic analytical purposes; from fresh individuals or spirit-specimens they would run as follows:—The colour of the animal is dark brownish grey, but a broad band or spot on the anterior margins of segments two to seven of the abdomen above is chalky white. The under surface of the abdomen is milk-white anteriorly, but posteriorly it becomes more and more brownish, with a small oval blackish-brown transverse spot on the anterior margins of segments three and four. The legs, especially on the under-side, are milk-white, but the upper surface of the femora and tibiae is somewhat brownish, as also the apices of the femora and tibiae; the first and second tarsal joints, the greater part of the third, and the whole of the fourth and fifth joints, are still darker; the last joint especially is remarkably dark. The antennæ are milk-white, but the apex of each joint is broadly black. The palpi are blackish grey; the halteres milk-white, with the knob brown. The underside of the head and prothorax are milk-white, as also the base of the wings, the rest of which are greyish, immaculate. The setæ on the thorax are whitish grey or slightly yellowish; the long setæ on the lateral margins of the abdomen pale greyish; on the legs the setæ are blackish grey or black, as also on the antennæ, the dense tufts of which, however, have a brownish tint.

I have not met with the imago in the open, but from the larvæ, which occurred in the beginning of April last year, in Boserup Skov and Jægersborg Dyrehave, a great number both of males and females were produced between the middle of April and the beginning of May.

XLV.—*Notice of a new Genus and Species of Lucanoid Coleoptera*. By CHARLES O. WATERHOUSE.

AUXICERUS, n. gen.

General characters of *Scorticus*; very depressed. The anterior coxæ only a little separated; the prosternum not produced into a process posteriorly. Mesosternum sloping down in front. The four posterior tibiæ straight and not armed with a spine on the outside. Eyes not divided by the canthus.

♂. Mandibles a little longer than the head, horizontal, acuminate, and slightly curved. Head large and broader than long, the anterior angles produced into an acute process.

Clypeal margin emarginate. Basal joint of the antennæ as long as the head (measured in the middle), flexuous; the second to seventh joints slender, about twice as long as broad; the first and second joints of the club with the lamellæ occupying only the apical half of the joint, so that the lamellæ are widely separated from each other; the lamella is only spongy on the side which is towards the apex; the apical joint is compressed, reniform, and spongy, except the base, which is shining. Thorax transverse, the posterior angles obliquely emarginate. Mentum strongly transverse, rounded at the sides, widely emarginate at the apex.

Auxicerus platyceps, sp. n.

♂. Parallelus, sat depressus, opacus, pallide squamosus; mandibulis porrectis, apicem versus acuminatis, basi denticulatis; capite lato, medio planato, angulis anticis supra obtuso carinatis, longe acute productis, divergentibus; thorace capite vix latiori, medio convexo, canaliculato, lateribus piceis, angulis anticis prominulis, angulis posticis oblique emarginatis; elytris thorace paulo angustioribus, parallelis, ad apicem arenatim angustatis, regione suturali depresso, crebro, evidenter punctato, macula humerali, altera laterali ante apicem obscuro piceis, macula sub humero, fascia pone medium undulata, plagaque apiculi squamarum pallidarum

ornatis; tibiis anticis extus quinquedenticulatis, posticis incrinitibus; corpore subtus sat nitido, rufo-piceo variegato.
Long. 13 mill., lat. 5, mandib. long. $3\frac{1}{2}$.

The mandibles are a little longer than the head, very slightly turned up at the apex; there is a carina which commences in the middle of the base, and turning along the outer edge terminates in an obtuse scarcely raised tooth a little way from the apex; another carina commences at the base near the other, and runs along the centre of the mandible to about the middle; the space on the inside of the mandible is thickly punctured; there are three or four small obtuse teeth at the base. The ocular canthus only encroaches a very little way on the eye. There is a slight tumour behind the eyes. The sides of the thorax are somewhat parallel, with a very gentle sinuosity before the posterior emargination; the commencement of the emargination is marked by a distinct slightly prominent angle. The anterior and posterior margins are impressed; the disk is moderately thickly and very finely punctured. The pale sandy scales, which are generally scattered over the surface of the insect, are on the elytra crowded together and form a patch below the shoulder, a band rather behind the middle (somewhat in the form of a **W**), and a patch at the apex. The underside of the head, the base of the femora, and the metasternum are pitchy red, the latter shining; the abdomen is black, rather thickly and moderately strongly punctured.

Hab. Peru, Chanchamayo (*Tham*). Brit. Mus.

Scortizus cucullatus, Blanch.

This species, described originally as a *Lucanus*, is placed by Solier and Burmeister in the genus *Sclerostomus*, and I see no serious objection to its being so placed. The slightly produced prosternal process and concave mesosternum agree with that genus. *Scortizus*, on the other hand, has the prosternal process more prominent, and the mesosternum is also conically produced in front.

The species appears as a *Scortizus* apparently first in Major Parry's "Catalogue of Lucanidæ" (Trans. Ent. Soc. 3rd ser. ii. p. 94).

XLVI.—*Descriptions of new Lepidoptera from the Viti Islands*
By ARTHUR G. BUTLER, F.L.S., F.Z.S., &c.

THE following new species have been received from the Goderfroy Museum:—

RHOPALOCERA.

1. *Catochrysops vitiensis*, sp. n.

♂. Wings above dull smoky grey, changing in some lights to dull lilacine blue; fringe blackish, grey at the tips; head and thorax blackish; abdomen smoky grey. Wings below pale brownish ash-grey, traversed by numerous undulated whitish-edged brown lines in pairs, so as to form ill-defined bands; across the primaries are three of these bands, the first just before the basal third, oblique, slanting slightly outwards from the costal to the submedian vein; the second abbreviated, closing the discoidal cell, its outer edge with a prominent central process, its inferior extremity touching the third band, the latter crosses the disk, from costal to submedian vein, parallel to outer margin, and is followed by a submarginal series of brown crescentic markings with white edges on both sides, again followed by a nearly marginal series of ill-defined dusky spots; a very slender blackish marginal line; fringe whitish, with a dusky central line; the bands on the secondaries are a modification of those on the primaries, but being necessarily more crowded together, the second and third bands appear to form a single belt, its inner edge nearly straight, and its outer edge arched, the centre therefore being very wide, composed of four lines and enclosing between the pairs a mere comma-shaped trace of the ground-colour; the submarginal crescentic markings are also modified, three towards apex remaining in their normal condition, but the others uniting into a slightly undulated arched line, so as to enclose a broad golden ochreous patch from anal angle to third median branch, upon which are four black-edged metallic emerald-green spots—two large, rounded, with conspicuous black centres, on the median interspaces, and two small towards anal angle; margin and fringe as in primaries; base broadly blackish irrorated with white; body below greyish white; the palpi black, with the base of their fringes white. Expanse of wings 26 millim.

Viti Islands (December 1878).

2. *Belenois inopinata*, sp. n.

♀. Most nearly allied to *B. charina* of South Africa,

which it resembles not a little on the upper surface; much larger; above milk-white; primaries with blackish costa; three black spots in an oblique series about halfway between the discoidal cell and apex, the central spot small; a fourth spot just beyond the middle of the second median interspace; apex black, continuous with three partly confluent conical spots on outer margin, the last of them at extremity of second median branch; base of all the wings sparsely sprinkled with blackish scales: body blackish, the thorax clothed with white hair, and the abdomen irrorated with white. Primaries below milk-white; costa suffused with sulphur-yellow; discal black spots as above; outer border greyish from costa to second median branch and internally suffused with sulphur-yellow; secondaries and pectus sulphur-yellow; venter white. Expanse of wings 56 millim.

Viti Islands (24th August).

3. *Belenois clarissa*, sp. n.

♀. Primaries above milk-white; costal border black, a broad oblique black patch, with sharply-defined angles at the end of the cell, the upper extremity of this patch confluent with the costal border; veins beyond the cell black; apical third of wing (forming a broad external border, decreasing in width to external angle, and with irregularly zigzag inner edge) black; six subapical oval white spots, slightly tinted with sulphur-yellow, the second and third large, the second being largest: secondaries pearl-grey (owing to the transparency of the wing, which shows the black colouring of the under surface through it), a diffused oval patch in the cell, six in an angular series beyond the cell, and the abdominal border milk-white; a large black spot at the extremity of the cell; veins beyond the middle of the wing black; a broad irregular black external border, on which are six oval pale sulphur-yellow submarginal spots in a decreasing series: body above grey, with whitish hairs on the thorax. Primaries below with the markings nearly as above, but more sharply defined, an additional subapical spot within the subcostal furca; the whole ground-tint of the wing, but especially the discoidal area and submarginal spots, suffused with sulphur-yellow: secondaries black, the base of costa, a large elongate patch on basal half below the costal vein, a second in the cell, a dash at base of interno-median area and the abdominal border (divided by the black internal vein) pale sulphur-yellow; an angulated series of seven elongated spots across the disk paler yellow, almost white; a submarginal series of six bright sulphur-

yellow spots, much larger than those on the upper surface; pectus yellowish, venter white. Expanse of wings 57 millim. Viti Islands.

Allied to *B. teutonia*, but readily distinguishable by the absence of orange colouring from the under surface.

4. *Ismene bilunata*, sp. n.

Wings above dark fuliginous brown, growing considerably paler towards the base, where there are a few greenish opaline hairs: primaries with two semitransparent white crescents placed obliquely before the middle of the median interspaces; fringe of all the wings tipped with white: body above greyish brown, the head and prothorax shot with opaline green; palpi sordid white, with a black external lateral line and black terminal joint. Wings below mouse-brown, primaries with the median area blackish, especially towards the base; crescentic markings as above, apical area greyish, bounded internally by a transverse elbowed lilacine whitish streak: secondaries crossed beyond the middle by a rather narrow and nearly straight white stripe, which is interrupted towards its posterior extremity by a large black quadrate anal patch; a slender white stripe at the base of the fringe, beginning at the black patch and running a short distance upwards towards the apex, but gradually fading away long before it reaches it: abdominal area faintly glossed with pink and green tints; pectus greyish; the femora white above, grey at the sides; tibiae and tarsi grey above and more or less ochreous below; venter creamy white, barred with pale grey. Expanse of wings 52 millim.

Viti, "Koro" (? Goro).

Allied to *I. ulesis* ♀ of S. India and Ceylon, but differing in the smaller crescents on the primaries, the much less lilacine tint of the under surface, and the much more defined white stripe across the secondaries.

XLVII.—On some new Siliceous Sponges collected by M. Pechuël-Lösche in the Congo. By Dr. WILLIAM MARSHALL*.

[Plate XV.]

EXCEPTIONAL forms of animals and plants deviating in some respect or other from the general rule have ever excited

* Translated from a separate copy of the Memoir sent by the author to H. J. Carter, F.R.S. The original appeared in the 'Zeitschrift für Naturwissenschaften,' Neue Folge, Band ix. pp. 553-577.

special interest among naturalists. The extraordinary is always adapted to impress us particularly, and especially the extraordinary in the organic world: to the many mysteries which every creature hides within itself we have here added a new one, which asks us how does this particular creature come to differ so completely from the ordinary pattern? what were the constraining causes of this, and how is it modified by them in its whole organization? Parasitism and subterranean mode of life lead to such aberrant phenomena, as also the adaptation of terrestrial forms to an aquatic life, and *vice versâ*; those organisms especially which, belonging to a group otherwise exclusively inhabiting fresh or salt water, have emancipated themselves from this general rule of life of their relatives, and taken up their abode in the sea or fresh water in opposition to it, have always attracted and still attract particular attention. Ten new marine Medusæ could not have caused so much stir as *Linnocodium palustre* alone!

In this way also it comes to pass that much attention has for a long time been paid to the freshwater sponges, and that even small contributions to the knowledge of these remarkable organisms may expect to meet with more consideration and a more favourable reception than, for example, the description of a number of new Ascones or Renieræ. This conviction encouraged me in the following paper to make known some new freshwater sponges, which may perhaps also lay claim to a special interest on the ground of their origin.

General Part.

Before passing to the special descriptions I may be permitted to premise some remarks of a more general nature, in which I shall confine myself to a historical introduction, as it is my intention to revert to the subject in a memoir of wider extent upon the freshwater sponges.

No zoologist of the present day can doubt that our freshwater sponges are derived from marine forms, and that they are the descendants of the latter modified by their mode of life. We have therefore only to ascertain what are the relationships of the freshwater sponges to one another and to the marine sponges, and how far they are altered by residence in fresh water.

Most investigators of our objects seem tacitly to be of opinion that all non-marine siliceous sponges are nearly allied, at any rate more nearly than to marine sponges; and that they form a well-characterized group, the members of which have originated directly from each other, and these from a common marine form. This is possible, but certainly not more!

It is just as possible that in the freshwater sponges there

are several series of forms which may be derived from different although perhaps nearly allied marine ancestors, the peculiar resemblances of which would then be rather apparent and acquired by similar adaptations, and consequently resting on analogy, but not inherited in common, and consequently homologous; in other words, that *the freshwater sponges had not a monophyletic, but a polyphyletic origin*. It seems to me worth while to dwell for a moment upon this consideration, and to weigh the *pro* and *contra* of these two possibilities. Although at the outset I see clearly enough that at present no definitive settlement of the question with demonstrative force can be arrived at, and that perhaps such a settlement never will be attained, this shall not prevent me from placing side by side with the current hypothesis (for the assumption of a monophyletic family of "*Potamospongiæ*" is no more than this), another one which perhaps may be no better, but is certainly not worse.

If we ask, in the first place, in what do the different siliceous sponges of the freshwater agree? the answer is, in three points:—first, they are Monactinellids; secondly, they inhabit the fresh water; and thirdly, most of them, besides sexual reproduction, present an asexual reproduction by means of special buds (*gemmulæ*, *sphæculæ*, *statoblasts*, &c.) provided with a more or less developed siliceous armature, which are developed at certain seasons at the expense of the parent animal, and are usually associated with the decay of the latter.

The first two points are wholly irrelevant in judging of the relationships of the so-called *Spongillæ*; as a matter of course these are certainly more nearly allied to a *Vioa* or similarly aberrant Monactinellid (always supposing that these are themselves really of monophyletic origin, which, from my observations, I have good cause to doubt) than to a Tetractinellid or Hexactinellid; but for the recognition of the phylogenetic relations of the individual species to each other and to the legions of marine Monactinellidæ (which, so far as we can see at present, form at least 75 per cent. of the living siliceous sponges), we do not gain much from them. The second point, the residence in fresh water, will hardly be seriously regarded by any one as coming into the balance; from this we can only conclude that there are sponges, as well as numerous other inhabitants of salt water, which are able to adapt themselves in this particular*. There remains therefore only the

* See the valuable memoir by E. von Martens in the '*Archiv für Naturgeschichte*,' 1857, p. 149, in which, however, no consideration is given to the sponges, which indeed at that time were not universally admitted to be animals. See also Semper, '*Existenzbedingungen*,' pp. 180-281, ii. 125.

third. point, viz. the production of gemmules, that can be regarded as a fundamental criterion of a sponge belonging to the group of the Spongillina of Carter, as indeed is done by Carter * when he characterizes the group thus:—"Bearing seed-like reproductive organs called 'statoblasts.'" According to this the species of the genus *Lubomirskia* from Lake Baikal would be at once excluded, for, according to Dybowski's † positive assertion, they have no gemmules.

But are these gemmules of the other freshwater sponges really so eminently characteristic that they alone are capable of demonstrating the relationship of those sponges? or may they not make their appearance as new formations *sui generis* in originally different forms—that is to say, in forms of different origin? This is open to discussion.

Besides sexual reproduction an asexual process seems to be rather widely diffused among sponges. Leaving out of consideration the gemmule-formation in freshwater sponges, it has been observed in Gummineæ (*Halysarca*, F. E. Schulze), Monactinellidæ (*Rinalda*?, Mereschkowsky), Tetractinellidæ (Tethyadæ, Deszö, Selenka, Perceval Wright), and very probably in Hexactinellidæ; at least the young individuals observed by Carter ‡ on the lateral tufts of spicules of adult *Rossellæ* seem to me to belong to this category of buds, as indeed the above-mentioned naturalist himself remarks, "It seems probable, if these [several minute specimens] do not originate in ova which have respectively fixed themselves there for development, that they arise from pullulation or budding." I am now even inclined to interpret as buds the young forms discovered by me in the body-cavities of a specimen of *Hyalonema Sieboldi*, and previously described as embryos §.

According to Selenka || each bud in *Tethya maza* consists of at least from five hundred to one thousand mesodermic cells, and it is his opinion that in the Tethyadæ asexual and sexual reproduction are mutually exclusive; in *Tetilla radiata* from Rio de Janeiro he found during the winter months, from June to August, no ova in course of segmentation along with the buds. I have myself repeatedly examined *Tethyæ* in the budding state, both living (at Corfu) and very well preserved, and especially a number from the Tonga archipelago were of

* Ann. & Mag. Nat. Hist. February 1881, p. 88.

† "Studien über d. Spong. d. russ. Reichs," Mém. Acad. St. Pétersb. sér. 7, tome xxvii. no. 6, p. 11.

‡ Ann. & Mag. Nat. Hist. ser. 4, vol. xv. p. 118 (1875).

§ Zeitschr. f. wiss. Zool. Band xxv. Supp. p. 216.

|| Zeitschr. f. wiss. Zool. Band xxxiii. p. 473.

great interest to me. These were of two different sizes; some were on the average about 3 centim. in diameter, the others only 1 centim.; in other respects they had exactly similar skeletal elements and exactly the same structure. In this indeed there was nothing surprising; one could simply regard the smaller specimens as younger; but there was one phenomenon that could not easily be brought into agreement with this view—the larger specimens, so far as they were investigated, showed no sexual products (ova) in the mesoderm, but were nearly all engaged in budding in different degrees; the smaller ones, on the contrary, without exception had ova, but never buds. In presence of these facts one could imagine two possibilities—the sponge in question might propagate sexually when young, perhaps during the summer, but asexually when older and in the winter; or we might have to do here with an alternation of generations, in that from the ova of a sexual smaller form an asexual larger one was developed, from which again the first sexual generation would bud.

With these buds of the marine sponges the gemmules of the freshwater sponges may very well be compared; both occur in addition to the sexual products and separated from them in point of time; both are primarily parts of the mesoderm, which, however, in the sea-sponges when separated pass naked to the surface and immediately commence an independent existence, apparently without any permanent injury to the parent animal; while in the freshwater sponges they become encapsuled, and for a time pass a latent existence in the interior of the dead parent individual. These are certainly noteworthy distinctions, but still not so very difficult to understand; we need only bear in mind that we have to do here with freshwater animals, and that the conditions of existence are essentially different for these and for marine animals. The latter have to suffer very little or not at all under periodically recurrent persistent want of food, their existence is not threatened for a time by the cold of winter or the drought of summer, their conditions of life remain from month to month, in one season of the year as in another, nearly the same, or vary too little to superinduce profound changes in the economy of these marine organisms. Matters are quite otherwise with the creatures dwelling in fresh water, which in this respect rather resemble inhabitants of the land than of the sea.

Some of them belonging to the faunas of warm countries are exposed during the hot season to the drying-up of the element in which they reside; and although this only takes place partially on the banks and here and there elsewhere, it suffices, especially in the case of adherent animals, to pro-

duce in them a sort of summer sleep, necessary for the maintenance of the species, which they pass either by the whole organism being in a state of latent vitality, or by breaking up into descendants (in the form of fragments of themselves).

What the desiccating heat of the sun is capable of doing in warm regions is effected in colder ones by the severity of winter; in both cases the animals are deprived of a part, and, indeed, a principal part, of their conditions of existence, food and moisture or heat, and in the two cases a similar result originates from partly antagonistic causes—side by side with the summer sleep of the tropical or subtropical organisms we get, as is so frequent, a winter sleep of those inhabiting colder zones.

The freshwater sponges, as is well known, do not fall in their entirety during the summer or winter sleep into a latent state of existence; this mode of persistence is perhaps conceivable only in forms living at very great depths, which are but little exposed to desiccation or to the action of cold. As whole organisms they for the most part disappear, and as they partially break up into germinal fragments, their modified seasonal sleep leads to a form of reproduction.

These germinal fragments, if they remained naked as when they are formed, would soon succumb to the power of the heat or cold. What had been acquired for the maintenance and increase of the species would be but badly preserved if from the first there had not also been acquired suitable defensive arrangements against these climatic influences, in the shape of shells which, in this respect quite analogous to the shells of eggs, could protect the germ as much as possible from freezing or desiccation, in short from destruction. Of such protected winter-eggs and winter-germs many occur, as is well known; and it would be interesting to know whether, in double-brooded insects for example, one brood of which passes the winter in the egg (there seem not to be many of them), these winter-eggs differ from the summer-eggs in the thickness of the shell, the mode of sheltering on the part of the mother, &c.; in other words, whether there is a seasonal dimorphism of the eggs. Unfortunately I have been unable to find any statements upon these points in literature; but Werneburg* says of the shells of the eggs of Lepidoptera in general that they differ in relative thickness and "are strongest in those which lie uncovered, and among these are particularly strong in those which remain undeveloped through the winter. Thus, for example, the eggs of *Bombyx neustria*, which re-

* 'Der Schmetterling und sein Leben:' Berlin, 1875, p. 46.

main uncovered through the winter, have harder shells than those of *Bomb. dispar*, which are clothed with a hairy covering."

There is nothing with which the gemmules of the *Spongillæ* can be better compared than with the statoblasts of the freshwater Bryozoa; and this comparison holds good and has been carried out* in every particular. Both are acquired under the same circumstances; both are portions of the main organism separated for the purpose of asexual reproduction; and they agree so closely, even in detail, in their structure, that Carter finds the only difference between them in their size and form. The statoblasts of the Bryozoa indeed have no armature of siliceous spicules, but yet their shells often possess peculiar contrivances which practically represent these in function. It is a fact of particular interest that, just as there are freshwater sponges without gemmules, there are also freshwater Bryozoa, not indeed without statoblasts, but with very slightly developed ones. The sponges in question are the *Lubomirskiæ*, which undoubtedly are perennial, like the marine sponges; some of them, indeed, attain great dimensions (they occur as much as 60 centim. in height), and it is not very probable that such a growth, not bound to an incrustable support, such as the twig of a plant, can take place in the course of a single summer. I know very well that *Spongilla*-stocks of considerable size are occasionally referred to, but the statements relating to them are not remarkable for accuracy; we are not informed whether these large specimens grew freely or whether they coated a branch, which, however, makes a very important difference; whether they were in full life throughout, or whether these giants were not perhaps an accumulation of different years, of which only the outermost part was still living. Moreover perennial individuals which in consequence grow to a considerable size are by no means inconceivable in suitable localities, and in these the formation of gemmules might then cease, or indeed, under certain circumstances, need never be acquired, as is the case in the *Lubomirskiæ*. These stand in the same relation to the other freshwater sponges as *Fredericella sultana* to the other Bryozoa of the fresh waters; the latter, according to W. Houghton†, is perennial, and certainly the small development of the statoblasts of this very species demonstrated by Allman is due to this circumstance.

* F. J. F. Meyen in Müller's Archiv f. Anat. und Physiol. 1839, p. 83; H. J. Carter, "On the Identity of the Seed-like Body of *Spongilla* with the Winter-egg of Bryozoa," in Ann. & Mag. Nat. Hist. ser. 3, vol. iii. p. 339 (1859).

† Ann. & Mag. Nat. Hist. ser. 3, vol. vi. p. 389.

This much is certain. The formation of capsuled winter-germs is by no means an exclusive peculiarity of the freshwater sponges, in which it does not even universally occur; it occurs in exactly the same manner in such very different animals as the Bryozoa, to say nothing of other analogous cases. But if so close a similarity is possible between the statoblasts of the latter and the gemmules of the former, are these gemmules really of decisive significance in the settlement of the question of the relationships of the freshwater sponges? Hardly; any more than the development of uti-cating organs can be decisive in judging of the relationships of the lower aquatic animals. What Bryozoa and sponges could acquire independently of each other, members of one and the same order can acquire *sui generis*, without any direct relationship between them being thereby demonstrated.

If, then, the different freshwater sponges agree in the structure of the skeleton, not only among themselves, but also in general with the majority of the marine siliceous sponges; if, further, as any one will admit, their common occurrence in fresh water is, according to all analogy, of no value whatever in the elucidation of their relationships; and, finally, if structures perfectly analogous with the gemmules can be acquired by similar adaptation by such perfectly different animals as Bryozoa, upon what is the assumption of a monophyletic origin for the so-called *Spongillæ* really based? This seems to me a question that may well be raised. It will justly be required of me that I should give the reasons that lead me to ascribe a polyphyletic origin to the freshwater sponges: these are their differences of form, their local distribution, and further also the conditions of derivation which must necessarily be assumed for other freshwater animals, notwithstanding their great similarity.

An artificial system will divide the freshwater sponges first of all into two great groups—those without and those with gemmules. In our consideration we shall also for the present accept these groups, although, as I will at once point out expressly, they cannot at all be regarded as natural and as expressing the true affinities.

The first group breaks up into the *Lubomirskiæ* and the *Potamolepides*, to the latter of which belong the new species hereafter to be described and probably also the genus *Uruguayæ*, Carter. As regards the *Lubomirskiæ*, these may be the youngest of freshwater sponges which still come remarkably near to certain marine sponges; close to them, and especially to *L. papyracea*, Dybowskyi, comes my *Potamolepis Leubnitzæ*; but probably no one will venture to assert that these sponges are directly

related to one another—the two are just very similarly modified descendants of different nearly allied marine siliceous sponges. One of them belongs to the comparatively modern relict-fauna of Lake Baikal, in which it dwells together with a whole series of inferior marine animals, and even seals; the other has wandered into the Congo, where it occurs together with very remarkable still undescribed bivalves of *Chama*-like habit, which adhere by one shell, and have a black epidermis as in the *Najades*.

*Uruguaya** seems to be very nearly allied to *Potamolepis* in habit, and especially to the second species, *P. Pechuelii*; and I would have named the group after this genus, if it had not a name so awkwardly geographical. A direct genetic connexion between these West-African and South-American forms may certainly be regarded as out of the question, for the relations and similarities between the Ethiopic and Neotropical faunas, multifarious as they are, are either due to analogies, or date back to a time when direct communication between the Congo and the Uruguay river by means of fresh water will hardly have existed †.

The other, very probably older, freshwater sponges have a common character in the gemmules—a character which I indeed, as already indicated, regard as of subordinate importance, but which, nevertheless, is serviceable for characterization in an artificial system. This second group again consists of two subgroups, the *Parmulinæ* and the true *Spongillæ*, which are remarkably distinguished from each other in their general habit. The former are eminently rigid, and in other respects also, especially in the gemmules themselves, present important peculiarities; they are neotropical and distributed especially in the Amazon and its affluents.

The second subgroup, that of the *Spongillæ*, is circumpolar, Palæarctic, Nearctic, Indian, and Ethiopic, with forms pushed forward, on the one hand, to the Amazon (*Sp. navicella*, *Meyenia gregaria*, and the species of the genus *Tubella*, Carter); and, on the other ‡, to the Mauritius (*Sp. Carteri*), and even, which is very remarkable, as far as Australia (*Meyenia Capewelli*, Cart.), and consequently is nearly cosmopolitan. For these forms a direct genetic connexion may be possible, but not more probable than spontaneous formation. In the structure

* A genus established, but only as provisional, by Carter, Ann. & Mag. Nat. Hist. ser. 5, vol. vii. p. 190.

† See A. R. Wallace, 'Geographical Distribution of Animals,' vol. ii. p. 81.

‡ See Carter's memoir in Ann. & Mag. Nat. Hist. ser. 5, vol. vii. pp. 77 et seqq.

of their gemmules the *Spongillæ* show peculiar and very significant differences. Some of them (*Sp. lacustris* &c.) are adapted for swimming; others (*Sp. Carteri*, *nitens*, &c.) for swimming and passive movement; others, again, are essentially heavier (*Meyenia*); but all can easily get from one locality to another by the well-known means of transport of the lower aquatic organisms, namely birds*.

The occurrence of *Sp. Carteri* (which has hydro- and acrostatically adapted gemmules, and was previously known only from India, although possessing allies in Africa, namely *Sp. nitens* from the White Nile in the Leipzig Museum) in the Mauritius† is very remarkable, although that island lies in the south-east trade-wind belt and in the southerly diverging branch of the trade-drift flowing from east to west; but we see that the Mauritius, besides some autochthonous forms, possesses a very remarkable mixed fauna, in which Ethiopic and Oriental, and even some Australian, elements meet together.

These considerations may, in a certain sense, be compared with those which Huxley‡ has put forward as to the origin and derivations of the freshwater Crayfish. The great biologist shows that there are two families, well characterized by certain peculiarities, of such Crustaceans, one of which, that of the Potamobiidæ, inhabits the northern, and the other, the Parastacidæ, the southern hemisphere. He supposes that both families descend from a widely distributed primitive form, living in the sea, which he names *Protastacus*, and which has wandered into the fresh waters, and here become differentiated into the ancestor of the Potamobiidæ in the northern parts of the earth, and of the Parastacidæ in the southern; and hence that the river Crayfish, notwithstanding their differences, are of monophyletic origin§.

It is, however, in my opinion, very possible that this hypothetical *Protastacus*, while still an inhabitant of the sea, may have existed under two, three, or even more different forms, local races, or whatever they may be called, and that these, after passing into a different medium of existence, still further adapted themselves to the latter. For a whole series of other organisms of the freshwater, the geographical distribution of which would otherwise be quite unintelligible (such as

* I reserve these various modifications of the gemmules and their probable causes for treatment in a subsequent memoir.

† According to a kind epistolary communication from Mr. Carter.

‡ Proc. Zool. Soc. Lond. 1878, p. 752.

§ See also Jhering, "Die Thierwelt der Alpenseen und ihre Bedeutung für die Frage nach der Entstehung der Arten, in Nord und Süd," Band x. p. 242 (1879).

the crocodiles, many fishes, &c.), we must have recourse to similar ancestors which have lived in the sea.

For the explanation of the origin of the freshwater sponges the conditions, I believe, are much more favourable: here we have in truth still living sea-inhabiting forms which perfectly agree, except for a few, small, and easily intelligible differences, with the former, as shall be immediately shown; in this case we have no occasion to reconstruct an ancestral form, which always has something doubtful about it.

In seeking for forms of marine sponges which might be the ancestors of the freshwater sponges, we must at once leave out of consideration the Hexactinellidæ, Lithistidæ, and Tetractinellidæ, less perhaps on account of the form of their skeletal elements than of their occurrence in deeper water; and of the Monactinellidæ which remain, the *Renieræ* press, as it were, of themselves into the first line. There can be no doubt that these sponges are at present engaged very actively in adaptation. In them we have a group in which, notwithstanding strong differentiation, the individual forms are most multifariously bound together; the struggle for existence will not long be fought between them in so high a degree, through which only in course of time, under fundamentally altered conditions of existence, it will come to pass that the surviving members of the group, like the mountain-tops of a sunken land protruding as islands from a flood, as sharply-defined species will represent well-characterized genera. *Renieræ* are distributed in all seas, from the tropics to Greenland and Kerguelen's Land; they occur (*Pellina profunditatis*, O. Schm.) from a depth of 324 fathoms*, upwards, as far as existence is still possible for truly aquatic animals. Of *Reniera caruncula* of the English coast, Norman† says: "On rocks between tide-marks. This is one of the regular tide-mark sponges." On the rocky coast of Enoshima, Döderlein‡ found *Renieræ* in places which at low tide were just sprinkled with water; the Mediterranean *Reniera littoralis*§ also descends only a few feet below the surface of the water, and *R. luxurians* is even frequently left dry by the ebb||. At the same time these sponges are always abundant, not only in individuals, but also in species; in the northern Adriatic over a dozen occur, and near Naples they form more than 24 per cent. of the existing Monactinellidæ (fourteen out of fifty-

* Schmidt, Spongien-Fauna des atlant. Gebietes, p. 42.

† Bowerbank's 'British Sponges,' vol. iv. suppl., ed. by A. M. Norman, p. 81.

‡ Archiv f. Naturg. 1883, p. 111.

§ U. Keller, Zeitsch. f. wiss. Zool. Bd. xxx. p. 580.

|| Schmidt, Spongien des adriat. Meeres, p. 12.

eight*). They are the sponges which persist longest in relict-faunas, and can adapt themselves to new forms; thus the Caspian Sea still harbours a true *Amorphina* and three other Renierid species of a local genus, *Metschnikowia*, and these four are the only sponges of that great inland sea†. The *Renieræ* are almost the only Fibrospongiæ that can thrive in aquaria.

These polytropic organisms are able to bear with ease diminution of the amount of salt in the water, "as, indeed, in general the genus *Reniera* appears to be especially assigned to the lagoons and brackish water"‡. Thus O. Schmidt found the brackish bay of Argostoli, in Cephalonia, occupied by incredible numbers of various *Renieræ*; the Monactinellid fauna of Venice consists of more than 57 per cent. (four out of seven) of *Renieræ*, and one of them (*R. luxurians*) also occurs in canals where no other sponges grow, on walls immediately below the surface of the water§.

The *Lubomirskiæ* themselves, although they inhabit fresh water, come much nearer to the true *Renieræ* than to the *Spongillæ*, so near, indeed, that Micluchoff at one time did not hesitate to unite them with other forms of his true Renierid genus *Velupsa* (*polymorpha*) as an eleventh variety, *baicalensis*. In them the trains of spicules are cemented together by more strongly developed horny substance than in the *Spongillæ*, their oscula appear stellate, and gemmules or analogous structures are wanting. The cause of these differences may be, that in Lake Baikal (in which, moreover, a *Spongilla* occurs, having probably migrated back, as in the Gulf of Finland¶) the conditions of existence do not compel the sponges to be annual and to form gemmules; or it may also be that, since the *Lubomirskiæ*, as true *Renieræ*, were separated from their marine relatives by upheaval of the land, time enough has not elapsed for the acquisition of new peculiarities.

There is an important distinction in the fact that these sponges are, so to speak, passive inhabitants of the fresh water, separated by force from their relatives, while all the other

* According to Vosmaer, "Voorloop. Bericht omtrent het onderzoek" &c., 20 Nov. 1880–20 Feb. 1881, 6 pages, separately paged (? separate memoir, or reprint).

† There is a memoir by W. Czerniavsky upon the sponges of the Black and Caspian seas; but as it is written in Russian it does not exist for me.

‡ Schmidt, Spongien des adriat. Meeres, p. 73.

§ Schmidt, *loc. cit.* p. 76.

¶ Mém. Acad. Imp. Sci. St. Pétersb. sér. 7, tome xv. no. 3, p. 8.

¶ Dybowski, Mém. Acad. Imp. Sci. St. Pétersb. sér. 7, tome xxvii. no. 6, p. 66.

freshwater sponges probably quitted the sea gradually and voluntarily, and have adapted themselves in the course of a very long time; for, to say nothing of the Diluvium, sponge-spicules have been detected even in freshwater deposits of the Upper Jura*, the formation of which is long anterior to the origin of Lake Baikal.

All these facts certainly prove the remarkable pliability and adaptability which are possessed beyond all other sponges by the *Renieræ*, and these properties will very probably be the same all over the world. Under such circumstances, especially if we also bring in the structure of the freshwater sponges for comparison with the *Renieræ*, there is nothing more natural than to imagine that the former have originated from the latter, *but independently of each other in different parts of the earth, and with the appearance of similar modifications in structure and vital phenomena induced everywhere by adaptation*†.

A part of these modifications are new acquisitions (e. g. gemmules), and therefore to a certain extent of positive nature; others, however, are of negative nature, and relate to the disappearance of peculiarities of the marine *Renieræ*, especially to the loss of colour. Most of the *Renieræ* occurring freely and at the surface are intensely and often even very intensely coloured (orange, red, velvet-black, &c.); and I have no hesitation about regarding these colours (as I have already done‡) as alarming or warning agents which deter other animals, not from eating the *Renieræ*, for they are not generally fit for food, but from injuring them in their existence by fruitless attempts to eat them. Now we know that retrogressions,

* Young, Geol. Mag. 1878, p. 220.

† How great, indeed, the power of adaptation is in the freshwater sponges is strikingly proved by the interesting discovery of Dr. Joseph (59 S., B. d. schles. Ges. f. vaterl. Cultur im Jahre 1881, p. 253), who found in the Grotto of Gurk in Carniola, an absolutely *transparent* (!) form of *Spongilla* (*Sp. stygia*, n. sp.). As I supposed that this freshwater sponge, which will find itself all the year round under the same, or nearly the same, conditions of existence, would form no gemmules, as these would be superfluous, I applied by letter to Dr. Joseph, who forwarded some preparations to me, and at the same time kindly wrote, among other things, as follows:—"Your supposition that no formation of gemmules takes place is correct, for *neither in September nor in April did I find any*." Some people may perhaps think that the *Spongillæ* of the Grotto of Gurk were not descended from ordinary *Spongillæ*, but directly from Monactinellidæ of salt water, perhaps at a time when the waves of the Tertiary sea eroded the grottoes of Carniola and Friuli. This would have much less probability than the supposition that in consequence of uniform conditions of existence, not dependent upon the seasons, retrogression as regards the gemmules has occurred in *Spongilla stygia*.

‡ Zeitschr. f. wiss. Zool. Bd. xxxvii. p. 245.

which, if we may so speak, are to be accounted for by a tendency to saving in Nature, scarcely occur more strikingly than with respect to offensive and defensive colours. These disappear immediately when the pressing necessity which called them forth is got rid of; and it would seem that the enemies by which *Renieræ* in sea-water might certainly be threatened and disturbed did not migrate after them into the fresh water, and there the varied coloration disappears, just as in the *Renieræ* which live concealed under stones &c. That green *Spongillæ* occasionally occur is due, as is well known, to a symbiotic process, and is no integral property of those sponges.

Although the conviction of the connexion of the freshwater sponges with the *Renieræ* has never, so far as I know, been developed in detail in zoological literature, I have repeatedly supported it, especially in conversation with scientific friends, and Claus gives expression to it in his text-book *. Other naturalists indeed seem to be of a different opinion, such as Keller †, who regards the *Spongillæ* as well as the *Esperiæ* as groups quite distinct from the *Renieræ*; and Carter ‡, who occupies the same standpoint in 1881 as in 1875; and although he places his "Potamospongida" in the same order (Holorhaphidota) with the Renieridæ, separates the latter as his first from the former as his fifth family, by the Subcritidæ, Pachytragidæ, and Pachastrellidæ (*i. e.* by the whole of the Tetractinellidæ, including the Lithistidæ), or, in other words, at least if his system is to be taken as expressing his ideas of the relationships, the relations of affinity between the freshwater sponges and the Renieridæ are but slight, at any rate slighter than those of the two groups with the Geodia for example.

Against my hypothesis of the polyphyletic origin of the freshwater sponges evidence from facts can hardly be brought forward; and although I cannot prove it, it seemed to me not without interest to bring this question under discussion. I may here, however, expressly state that it is not and cannot be at all my design to break up the group of the freshwater sponges; even from considerations of convenience it is desirable to adopt a Renierid group of "Potamospongiaæ."

* Grundzüge der Zoologie, 3 Aufl. 1876, p. 194.

† "Upon the latter point the less weight can be laid, as a similar structure occurs in quite different groups (*Spongilla*, *Esperia*)." Zeitschr. f. wiss. Zool. Bd. xxx. p. 564.

‡ Ann. & Mag. Nat. Hist. ser. 5, vol. vii. p. 85.

Special Part.

POTAMOLEPIS, n. gen.

Monactinellid siliceous sponges of the fresh water of great brittleness, with curved, obtuse, smooth spicules, which (when dry) are closely cemented together by a small quantity of organic substance. No gemmules [statoblasts].

1. *Potamolepis Leubnitziae*, n. sp.

Forming crusts of 1-1.5 millim. thick, finely porous, of yellowish-white colour and silky lustre, exactly of the appearance of very under-baked wafers. The surface presents a few crateriform elevations of 0.25-0.40 millim. in height, standing in not very distinct rows upon faint undulations, which divide dichotomously in both directions, and frequently disappear, and in which a certain parallelism is unmistakable. At the summit of each elevation there is an osculum of irregular elongate ovate (length to breadth as 1 to 0.5 millim.) and sometimes elongate triangular or pentagonal form, separated from each other by from 1 to 4 millim., but usually by 2 millim. The mouths, which are usually furnished not with smooth but with finely-notched margins, lead into very shallow (0.5 millim. deep) gastric spaces, which immediately break up into several canals; in the angular mouths the opening of a canal of this kind is in general placed in each angle. The canals run horizontally, branch dichotomously, and communicate frequently with the canal-systems of neighbouring oscula. The very numerous and closely-placed incurrent apertures are round and about 0.1 millim. in diameter; between them are situated many much finer apertures, which, in the fresh state, are probably covered by ectoderm.

The three specimens before me formed a thin crust coating flat fragments of stone. Many parts of the latter, especially where other animals (apparently dipterous larvæ forming adherent cases of sand) had seated themselves, were not overgrown.

2. *Potamolepis chartaria*, n. sp.

Oral cone isolated, with round entire margins 0.3-1 millim. in diameter; incurrent orifices not numerous, 0.1 millim. in breadth. Surface like blotting-paper, with a dermal skeleton composed of very delicate, felted straight acerates attaining a length of 0.08 millim. Colour in the dry state chocolate-brown.

This species much resembles the preceding in habit and the

form of the proper skeleton-spicules, but is well characterized by the round oscula, and especially by the presence of a dermal skeleton. In consequence of the presence of this dermal skeleton the surface of the sponge acquires a peculiar paper-like appearance, and at first I was inclined to regard this coating as consisting of fine dried mud. Microscopic examination, however, soon taught me better. The dermal spicules lie irregularly (tangentially at the incurrent and excurrent apertures) in a tolerably thick crumbly mass of dried substance which cannot be removed, but rather adheres very firmly to the underlying skeletal parts. The colour of the organic substance, especially of that cementing together the proper skeletal elements, is chestnut-brown. It is possible that this colour is to be accounted for by the great amount of iron in the Congo (almost all Africa is exceedingly rich in iron), which colours the surface of the stone as if with black-lead and penetrates several millimetres into it; but in this case it is certainly wonderful that the other sponges found there under precisely similar conditions show no trace of it.

3. *Potamolepis Pechuëlii*, n. sp.

Crust-like, with numerous oscular cones as much as 10 millim. in height, which are so compressed laterally that one diameter of the base is in proportion to the other as 1 to 2. The cones stand in the single specimen in the direction of their longest diameter in indistinct rows, which diverge radiately from one spot on the margin; only quite exceptionally do they stand perpendicularly to the adherent base of the sponge, but most of them ascend with an inclination of 45° in the direction of the greater diameter, and in all the inclined side is turned towards the point from which the rows of cones radiate, while the other side descends steeply. At the summit of each cone there is a mouth-opening (in some which are fused together, two), which is simply round, and may attain a diameter of 3 millim. These oscula lead into simple short gastric spaces (4 millim. deep in the longest cones), and these break up into a gastro-vascular system, which is not further traceable. The spicules present a somewhat slenderer form and somewhat smaller curvature than those of the other two species; they are cemented together by a small quantity of organic substance into coarse trains as much as 1 millim. broad, which, crossing each other irregularly, form a very confused network with meshes of very unequal size (0.5–2 millim.) and quite dissimilar form, in some of which, very probably, there will during life have been at least incurrent apertures. The network is developed in exactly the same

manner upon the mantle of the cones as in the interspaces and in the interior of the sponge. The colour of the dry sponge is ash-grey with a silky lustre, and this and the large size of the meshes give it the appearance of a coarsely porous pumice-stone.

With regard to the conditions under which the *Potamolepides* occur, their discoverer, Dr. Pechuël-Lösche, has given me orally detailed information. The specimens come from above Isangila, a place which is distant from the sea about 150 nautical miles by water, and is situated upon the Congo more than 100 metres above the sea-level. They were also observed near Kalubu, about 50 nautical miles further up the stream. Between the place where they were found and the sea the river forms six falls and rapids—namely, near Yilala, Manguvu, Inga, Nsongo Yilala, Ngoma, and Isangila itself. In the actual bed of the river, on the constantly submerged rocks, they were not observed, which, however, may have been a matter of chance; but the rocks of the inundation-region at the sides were in places thickly covered with them, so that, as the greater part of the sponges are white, this gave the rocks the appearance of being covered with the excrements of the wading birds which are so numerous there, as indeed my honoured friend at first believed to be the case. The most remarkable thing is that these rocks, which, during the high water of the summer, with its rapid flow (of about one German mile per hour), are from 2 to 3 metres under the surface of the water, lie, during the months of June, July, August, and half September, perfectly dry under the scorching heat of an African tropical sun. The sponges were collected in July. These rocks belong to one of the clay-slates striking from south-east to north-west and dipping to the south-west, and are covered with sponges only on their eastern side, which is towards the stream and more or less overhangs it, and here, which is sufficiently important, with all the three species together. Frequently spaces of a square metre are overgrown, but not so that the sponges form a connected coating; they certainly stand close together, but always in distinct colonies not bigger than a plate. On the diabase-rocks which cross the bed of the river near the rapids of Isangila, no *Potamolepides* were found. Their absence from these rocks need not by any means be due to an aversion of the sponges to this rock, and a preference for the clay-slate; at the spots where the diabase-rocks occur, and through them, the conditions of flow of the river will probably be so modified as to prevent any favourable development of the sponge.

In habit the *Potamolepides* show no resemblance to the *Spongillæ*, or indeed to any Renierid, and in their firmness and brittleness they much rather resemble certain Hexactinellidæ, especially *P. Pechuëlii*, which, in the microscopic structure of its skeleton, in the arrangement of its fibres, &c., greatly reminds one of a *Farrea*. I believe these remarkable peculiarities will become intelligible if we consider more closely the conditions under which the *Potamolepides* live. Here it is to be remembered above all that they live in running water, which certainly during the rainy season flows strongly, and will break with violence against the slabs of rock, and that they occur in opposition to the direction of the stream. In the presence of such factors a young sponge will not be able to grow into a branched shrub, or even into a turf-like cushion, in the same way as *Spongilla lacustris* or many *Lubomirskiæ* in still water: the pressure of the flowing water will rather compel it to cover its base of attachment with as thin a crust as possible, by which means a further advantage is gained towards its comfortable maintenance; the water surrounding it may indeed, as a destructive torrent, be rich in suitable nourishment, but it is too rapid in its movements and will leave the detritus contained in it for too short a time in one place to allow the sponge to derive much advantage from it, although indeed the chances may be somewhat more favourable on the overhanging side of a slab of rock than elsewhere in the bed of the river. The sponges take up their nourishment through apertures of the surface: when it is uniformly abundant and easy to obtain, the sponges may be cylindrical or conical, which, according to their ontogeny, seems to be their original form, and they need not adapt themselves to an increased reception of food. Thus in a round sponge, if we assume that the incurrent apertures are, under all circumstances, equally distributed, the proportion of the surface of the body (square) to the contents of the body (cube) suffices to nourish it, that is to maintain it and enable it to increase in size and reproductive products. The conditions are different if the food is scanty or difficult to obtain: then the above approximate proportion of the square to the cube will no longer suffice; the surface must be increased in proportion to the mass of the body, and with this the number of the food-receiving incurrent apertures must be increased. How can this be effected? Sometimes by the formation of pits, folds, intercanalicular spaces, pseudogastres, &c.; but this does not seem to be always admissible: residence on the underside of stones which do not form much of a hollow will put a veto upon it; but especially, as in the present case, very rough

water will not admit of it. The sponge must then seek in some other way to help itself, and this it can do only by forming a thin crust in which a large surface is developed with a small volume of body. This consideration leads to a series of consequences, to which I will here refer only *en passant*. On looking at a large, round, conical or cylindrical sponge with a smooth surface, we can assert, *à priori*, that it is produced under favourable circumstances, and has had not only abundance of food, but also the necessary quiet; another, composed of mæandrically united plates, interwoven branches, &c., and traversed by numerous intercanals, will have had quiet but a more slender diet; but a thin crust, unless it has been mechanically confined in extension by growth between stones, will have passed its life with very little rest and with a badly supplied table; and in the last-named case the sponges are also usually polyzoic with small personal regions. In connexion with this, the facts of individual development are very instructive; all young sponges are rounded, conical, or cylindrical, and, as a matter of course, the only question is, under what conditions they are further developed. By these their form is governed, and many species are in consequence exceedingly polytropic, showing an almost infinite power of form-variation; while others are in so high a degree monotropic that they rather die than make concessions to external circumstances in their form. There are extremely variable, but also extremely constant sponges, and these latter are naturally the rarer ones.

It is clear that the specimen of *P. Pechuëlii*, under somewhat different circumstances, with a less pressure of water, may have been more freely developed than the specimens of the other two species; but the influence of the moving water is unmistakable in the position of the oral cones and their tendency in one direction. Probably also the serial arrangement of the oscula which we recognize in all the species may be referred to the same cause; in *P. Pechuëlii* they lie also in the direction of the strike (direction of the greatest diameter) of the oral cones. In this sponge probably the central persons were not first developed, but those in the margin indicated by *a* in fig. 10. In very strongly moving water a sponge will scarcely be able to bud in all directions; the buds will rather always be formed in one direction, one behind the other, so that the younger will be somewhat protected by the older ones from the disturbing influence of the flowing water; this may lead to a radiate arrangement, for a current of water breaking upon an obstacle opposed to it does not reunite immediately behind it, where there is rather a quiet

spot which, if the obstacle was a ball suspended freely in the water, would have the form of a regular cone, but otherwise may be of various forms according to the configuration and position of the interposed object. In our sponge growing as a crust, the quieter space of water will have been approximately semiconical, at least for a certain distance, until the laterally diverted masses of water united again; and here the oral cones could become better developed than the anterior and older ones, which are more exposed to the force of the water, so that, under certain circumstances, the oldest oral cones will show the poorest development.

It may be objected that the freer development of the oral cones in *P. Pechuëlii* might indeed indicate a somewhat weaker pressure of water, but that the differences in the form and arrangement of the spicules of the different species are in this way by no means explained; for in *P. Pechuëlii* they are more extended and arranged in trains, whereas in the other species they are much more considerably curved and absolutely without any tendency to arrange themselves in bundles, both of which characters appear certainly to indicate growth in quieter water. I believe that this is only apparent; more strongly curved spicules will be able to interlock more closely than less curved or straight ones; they will form more compact masses, and so be able to oppose a more considerable resistance to the force of the currents, which will operate with effect in opposition to the efforts of the latter to arrange the skeletal elements of the sponge, whether they be proper to it or foreign bodies incepted to strengthen it, in trains in its own direction. A sponge with straight spicules under the very strong influence of a current acting in one direction must have a difficult task to maintain itself in position unless its spicules are remarkably spinous, or unless it differentiates auxiliary spicules in the form of hooks &c. In my opinion, to which I have already often given expression, the forms and arrangements of the skeletal elements of the sponges are for the most part to be referred to influences of purely mechanical nature, which, as they will frequently come into conflict with the inherited tendencies which dwell even in these structures, have led to that enormous abundance of often very wonderful adaptations to conditions which are usually, at least directly, still obscure. Besides the movements of the water acting from without, the currents in the interior of the sponge caused by the position of the flagellate chambers and the action of their ciliary organs will also be important factors in the construction of the skeleton; but very frequently also the position and nature of the flagellate cham-

bers will be governed by external influences (quantity of food and also again conditions of current). Experimental investigations in which sponges, and especially the exceedingly polytropic *Renieræ*, are brought under the most various conditions, must, I am firmly convinced, lead to the most astonishing results, and be of immense importance, not only for Spongiology, but also for the whole great theory of transmutation.

From such considerations it seems not unjustifiable to suppose that *P. Pechuëlii* and *P. Leubnitziae* are forms of the same species which have become differently developed under different circumstances; but so long as no transitions between them are known to us we must regard them as two species.

It only remains now to explain the reasons which have induced me to deny gemmules to the *Potamolepides*. I will lay no stress upon the fact that *P. Leubnitziae* and *P. chartaria* are too thin and have the spicules too closely interwoven to give room for such structures, as they might easily have acquired other arrangements, such as cavities for their reception; but if we consider that, according to what has gone before, the formation of gemmules in a tropical freshwater sponge is only intelligible during the dry season, while the specimens under consideration were, without exception, collected during the summer months, my view that they form no such gemmule-fragments receives very essential support. The specimens are so wonderfully preserved, even to the finest marginal parts of the oscula, that there can be no notion of their having died the year before or still earlier, and moreover it would be singular if the whole number of specimens examined were *accidentally* without gemmules. I have *never* found indigenous freshwater sponges *barren* (*i. e.* without products of asexual reproduction) in the autumn and winter, and a very considerable number of them have passed through my hands in the course of fifteen years. It is indeed possible that the non-differentiation of reproductive fragments might be a consequence of the different conditions of existence of the *Potamolepides*; but this seems to me not very probable, and I am more inclined to the opinion that, just like the *Lubomirskiae*, and probably also *Uruguayæ coralloides*, they have adapted themselves to existence in fresh water at a recent date in comparison with the *Spongillæ* and *Meyeniae*, and that, in case it should become necessary, the formation of gemmules may in course of time occur in them also.

In conclusion, I once more beg all my fellow-labourers to enable me to extend still further my investigations upon freshwater sponges by sending me abundant materials from all possible localities. Only the cooperation of many can bring

us nearer to the solution of certain general questions with regard to these interesting organisms. The greatest importance attaches to remarks appended to the specimens sent as to the time when the sponge was found, and the most exact possible statements (they can hardly be exact enough) as to the conditions of the locality, movement of the water, nature of the ground, amount of lime and salt (if any)—every thing is necessary to be known, for we cannot at all foresee what factors are of real importance in arriving at a conclusion.

EXPLANATION OF PLATE XV.

Potamolepis Leubnitzæ, n. sp.

- Fig. 1.* Beautifully preserved specimen upon a slab of stone, nat. size.
At *x* a colony of cases of larvæ (of Diptera?).
Fig. 2. Three oral cones, $\times 4$.
Fig. 3. Rubbed specimen, showing partially the course of the gastro-vascular system. $\times \frac{1}{2}$.
Fig. 4. Gastric space with ramifications, from the same specimen. $\times 4$.
Fig. 5. Skeletal elements in their natural position. $\times 30$.
Fig. 6. Two isolated spicules. $\times 100$.

Potamolepis chartaria, n. sp.

- Fig. 7.* Three oral cones.
Fig. 8. Skeletal elements; below are five spicules of the true skeleton, which are covered by a felted web of very fine uniaxial spicules. $\times 30$.
Fig. 9. Four isolated uniaxials of the dermal skeleton. $\times 120$.

Potamolepis Pechuelii, n. sp.

- Fig. 10.* Perfect specimen. α , oldest part.
Fig. 11. Two spicules.

XLVIII.—*Additions to the Australian Curculionidæ*.—
Part X. By FRANCIS P. PASCOE.

BRACHYDERINÆ.

Styreus, n. g.
— *geonomoides*.

LEPTOPINÆ.

Leptops punctigera.
— *incompta*.
— *vermicosa*.

GONIPHERINÆ.

Minia, n. g.
— *opalescens*.

HYPERINÆ.

Prophæsia florea.

DIABATHRARIINÆ.

Aronia agis horrens.

ATERPINÆ.

Iphisaxus æthiops.
 Rhinoplethes ignavus.
 Rhinaria tessellata.
 — signifera.

Rhinaria cavirostris.

— diversa.

Ethemaia angusticollis.

— curtula.

Hyphæria, n. g.

— assimilis.

Myarda, n. g.

— ferrugata.

STYREUS.

Rostrum breve, capite multo angustius; *scrobes* semilunares, apicales, ab oculis distinctæ. *Antennæ* tenuatæ; *scapus* brevis, articulo ultimo *funiculi* elongato; *clava* distincta. *Oculi* rotundati, prothorace distantes. *Prothorax* transversus, basi truncatus. *Scutellum* parvum. *Elytra* modice convexa, humeris obliquis. *Pedes* mediocres; *tibiæ* anticæ rectæ, intus denticulatæ, posticæ corbellis apertis; *tarsi* articulo tertio late bilobo; *unguiculi* liberi, approximati, inæquales. *Mesosternum* breviusculum. *Abdomen* segmentis duobus basalibus ampliatis.

The exponent of this genus has completely the *facies* of *Geonomus flabellipes*; and notwithstanding the different character of the rostrum, the open corbels, &c., I would place them in the same group.

Styreus geonomoides.

S. ovatus, griseo-squamosus; capite majusculo, linea impressa inter oculos; rostro antice concavo, in medio linea elevata nigra munito; elytris seriatim punctatis. Long. 5 lin.

Hab. Australia (North).

Ovate, covered with greyish scales; head large, rounded in front, with a narrow longitudinal line between the eyes; rostrum much narrower and shorter than the head, concave anteriorly; a black raised longitudinal line in the middle; first and second joints of the funicle longest, third nearly as long; club elongate, pointed; prothorax transverse, rather roughly punctured; elytra striate-punctate, striæ shallow, the punctures large, oblong, approximate, interstices broad; body beneath and legs with opalescent scales; innermost claw on all the tarsi smallest.

Leptops punctigera.

L. ovata, squamis griseis dense tecta, et setis nigris reflexis adspersa; rostro subtenuato; prothorace tuberculato; elytris seriatim grosse punctatis, interstitiis modice elevatis et late rotundatis. Long. $3\frac{1}{2}$ – $5\frac{1}{2}$ lin.

Hab. Port Bowen.

Ovate, closely covered with pale greyish, inclining to pearly, scales, and with scattered black, mostly recurved, setæ, those on the legs white; rostrum comparatively long and slender, three raised lines anteriorly; antennæ slender; scape attaining the eye, the latter ovate, not pointed below; prothorax scarcely longer than broad, rounded at the sides anteriorly, but parallel towards the base from a little before the middle; above with numerous subapproximate tubercles; scutellum small; elytra shortly ovate, not broader at the base than the prothorax, seriate-punctate; interstices slightly raised; punctures large, black, moderately approximate.

This species has the outline of *L. subfasciatus*; it is remarkable for its conspicuous black punctures.

Leptops incompta.

L. ovata, nigra, rude griseo-squamosa; rostro antice fere obsolete tricarinato; scrobe pone rostrum evanescente; prothorace ad latera subtuberculato; elytris striato-punctatis. Long. 5 lin.

Hab. Queensland.

Ovate, black, roughly covered with greyish scales; rostrum moderately stout, with three nearly obsolete raised lines anteriorly; scrobe gradually disappearing behind; eye transverse, pointed below; scape elongate; prothorax transverse, subtuberculate at the sides and partially at the base; scutellum punctiform; elytra striate-punctate, interstices broad, thickly set with erect cylindrical scales, punctures oblong, shallow, indistinct; body beneath and legs with silvery scales and slender setæ.

This species has nearly the same *facies* as the last, but with a different sculpture, eyes pointed beneath, &c. It is very like the Chilean *Strangaliodes albosquamosus*.

Leptops vermicosa.

L. breviter ovata, nigra, griseo-squamosa; rostro antice sulcis tribus munito; prothorace brevi, punctulato, lineis flexuosis inprossso; elytris seriatim grosse punctatis. Long. 4 lin.

Hab. Gayndah (Queensland).

Shortly ovate, covered with greyish scales; between the eyes a deeply impressed line; rostrum stout, with three grooved lines in front, the outer grooves short, the middle one extending to the apical plate; scrobe strongly developed; eye transverse, pointed below; prothorax short, impressed with flexuous or vermicular lines, the raised portions finely punctured, each puncture bearing a recurved seta; scutellum nearly obsolete; elytra only twice as long as the prothorax, seriate-punctate, punctures large, approximate, interstices slightly

raised and impinged upon by the punctures; body beneath and legs closely scaly.

A short species with a peculiarly sculptured prothorax.

MINIA.

Rostrum cylindricum, crassiusculum; *scrobes* medianæ, obliquæ. *Scapus* antennarum clavatus; *funiculus* brevis, articulo primo crasso, secundo breviori, cæteris transversis; *clava* magna, a funiculo distincta. *Oculi* rotundati. *Prothorax* transversus, basi bisinuatus. *Scutellum* punctiforme. *Elytra* modico convexa. *Femora* incrassata; *tibiæ* flexuosæ, muticæ; *tarsi* modice lati; *unguiculi* liberi. *Mesosternum* declive. *Processus* interfemoralis latus, truncatus. *Abdomen* segmentis duobus basalibus ampliatum.

Owing to its small size I am not quite able to satisfy myself as to all its characters; but its affinities appear to be between Gonipterinæ and Hyperinæ. I place it with the former on account of its thicker rostrum, but the *facies* is more that of the Hyperinæ.

Minia opalescens.

M. ovata, fulvo-rufa, squamis viridescenti-opalescentibus tecta; rostro capite paulo longiori. Long. 1 lin.

Hab. Clarence River.

About the size and shape of *Tychius junceus*; derm yellowish rufous, closely covered above and beneath with greenish opalescent scales nearly concealing the derm, but where the scales have been rubbed off the prothorax appears to be minutely punctured and the elytra striate-punctate; club of the antennæ as long as the preceding six joints together; first three joints of the tarsi nearly equal in breadth.

Prophæsia florea.

P. silacea, supra et in pedibus squamis argenteis adspersa et condensata; elytris striato-punctatis, interstitiis elevatis, setigeris. Long. 2 lin.

Hab. West Australia.

Brownish ochre, with silvery white scales scattered on the prothorax and legs, but condensed into a semilunar line behind the scutellum and on the suture posteriorly, also forming an oblique band-like patch midway on the side, ascending to near the line on the suture; elytra striate-punctate, interstices raised, each having a row of setæ; punctures in the striæ con-

spicuous, not approximate; body beneath covered with silvery scales.

This and the other species of *Prophæsia* are about the size and shape of *Hypera variabilis*; but this is the only one with raised interstices. The mesosternum is very slightly produced.

Aromagis horrens.

A. oblonga, fusca, squamis erectis adspersa; rostro breviusculo basi excavato, versus apicem planato, utrinque tuberculis marginato. Long. 3 lin.

Hab. Victoria.

Oblong, dark brown, with stout erect scales, here and there in tufts seated on tubercles; head with a tuft over each eye; rostrum rather short, excavated at the base, but becoming flattish towards the apex, each side with a row of erect tubercles; scrobe oblique, passing under the rostrum at a short distance from the base; antennæ short, stout; prothorax convex, rugose, slightly channelled in the middle, each side with two tufts placed transversely; elytra concave along the suture, bordered by an elevated line, on which are three tufts, the posterior considerably larger, slighter tufts and single scales at the sides; legs roughly tuberculate.

Shorter than *A. echinata*, differing in its rostrum and the obsolete punctuation of the elytra. Under a low power of the microscope the parts between the tubercles have a silvery tint.

Iphisaxrus æthiops.

I. sat anguste ovatus, niger, obsolete squamosus; prothorace granulis subnitidis sat sparse instructo; elytris regione suturali subplanatis, punctisque serialim impressis. Long. 4-6 lin.

Hab. West Australia.

Rather narrowly oblong, dull black; scales scarcely apparent; head with five or six large granules on each side, and numerous minute ones between them; rostrum rugosely impressed in front; antennæ slender, pitchy; prothorax convex, rounded at the sides, granules scarcely glossy, not closely approximate; elytra ovate; sutural region flattish, bounded externally by a slightly raised tubercular line, the tubercles larger posteriorly and accompanied by others at the sides, punctures in rows, shallow, especially on the sutural region; body beneath with scattered greyish scales, and punctured, each puncture bearing an elongate scale; legs with setiform scales.

A dull brownish-black species. It is differentiated from *I. asper* by its coloration and much more coarsely granulated prothorax. *Iphisaxus*, with its comparatively short metasternum, hardly agrees with *Aterpinæ*, yet there seems to be no place for it among any of Lacordaire's "tribes" with a long metasternum.

Rhinoplethes ignavus.

R. obovatus, piceo-fuscus; prothorace rugoso-punctato; elytris seriatim foveatis; antennis brevibus, funiculi articulo ultimo valde transverso. Long. 4 lin.

Hab. Champion Bay.

Obovate, pitchy brown, above with a few narrow erect scales; rostrum stout, tricarinated anteriorly towards the apex; antennæ short, stout, the last joint of the funicle nearly as broad as the club; prothorax coarsely punctured; elytra with large shallow foveæ arranged in rows; body beneath and legs covered with brownish scales and with black setæ interspersed.

This species differs from *R. foveatus* in colour, sculpture, and shorter antennæ. In that species, owing to their closeness, the foveæ assume a hexagonal form, giving the surface a reticulated appearance.

Rhinaria tessellata.

R. oblonga, pallide griseo-squamosa; elytris sat sparse nigro-tessellatis; rostro glabro, antice rotundato, scrobe transversa; tibiis anticis rectis. Long. 7-8 lin.

Hab. West Australia.

Oblong, covered with pale greyish scales, the elytra rather sparingly sprinkled with squarish black spots; rostrum straight, glabrous, glossy black, the scrobe transverse, lying almost directly beneath the eye, the divided lobe between the eyes continued to the rostrum, where it joins the bump between the insertions of the antennæ; the latter slender, the scape not much longer than the first joint of the funicle; club pointed; prothorax longer than broad, slightly produced in front, rounded at the sides, covered with numerous small glossy black granules, the scales between mostly brownish, but some forming three pale diverging stripes; scutellum small, densely covered with pure white scales; elytra less than three times the length of the prothorax, much broader than the latter at the base, striate, the interstices slightly raised, each with a line of glossy black granules; body beneath and legs with closely set greyish scales; fore tibiæ straight.

This species has the outline of *R. stellio*, but differs in its

transverse scrobe and short scape, as also in its straight fore tibiæ. I find *R. stellio* to vary in colour from a clean to a dirty white (as in the type), lightly spotted with ochre-yellow, which, in one specimen, is the predominant colour.

Rhinaria signifera.

R. oblonga, supra squamis fulvis brunneisque vestita; prothorace utrinque, elytris fascia juxta mediam, albis; lobo inter oculos producto, bifido. Long. 6 lin.

Hab. Australia (interior).

Oblong, covered above with fulvous scales, passing into brown at the base of the elytra and on the prothorax, the latter with the sides white, a broad band of the same colour just before the middle of the elytra; front between the eyes with a prominent bifid lobe; rostrum brownish black, scarcely excavated anteriorly, scrobe short, transverse; antennæ rather elongate, the scape shortish; prothorax longer than broad, narrowed at the apex, granules numerous, glossy black; scutellum subcordate, scaly, white; elytra broadest at the base, seriate-punctate, interstices raised, each with a row of glossy granules, punctures between the interstices partially masked by the scales; body beneath and legs covered with greyish scales; fore tibiæ nearly straight.

This species is allied to *R. myrrhata*; but, besides the different colour, the latter has the interocular lobe cleft into three portions, the lower portion, however, being indistinctly divisible into three, or five in all.

Rhinaria cavirostris.

R. anguste oblonga, squamis subaureis vestita; rostro brevi, antice valde excavato; scrobe profunda, apice incipiente, versus oculum valde ampliata. Long. 3 lin.

Hab. Queensland.

Narrowly oblong, covered with yellowish, under a strong lens somewhat golden, scales; lobe between the eyes prominent, rounded, entire; rostrum nearly glabrous, short, deeply excavated in front, bounded on each side by a sharp ridge, scrobe beginning near the apex, deeply impressed and expanding towards the eye; antennæ pitchy, first joint half as short again as the scape and of the two next together; prothorax longer than broad, anterior margin not narrower than the posterior, granules irregularly scattered; scutellum subtriangular, scaly white; elytra striate, interstices slightly raised, each with a row of somewhat distant granules, the

striæ with large approximate punctures, each with a scale at the base; body beneath and legs closely covered with greyish scales.

A small narrow species, remarkable for the form of its scrobes.

Rhinaria diversa.

R. anguste oblonga, squamis sordide griseis tecta; rostro breviusculo, antice excavato; scrobe profunda, angusta, apice incipiente, postice subito inflexa. Long. 4 lin.

Hab. West Australia.

Narrowly oblong, sparingly covered with dull greyish mixed with brown scales; rostrum rather short, concave anteriorly, each side of the concavity bounded by a prominent ridge; scrobe deep, narrow, beginning at the apex and suddenly bent inwards at the base; antennæ inserted nearly in the middle of the scrobe; scape short, but a little longer than the first joint of the funicle, the seventh confounded with the club; prothorax subglobose, closely punctured, the intervals granuliform; scutellum subovate, covered with white scales; elytra slightly broader than the prothorax, striate, the striæ indistinctly punctured, interstices moderately raised and bearing a row of flat glossy black granules; body beneath and legs with dispersed silvery scales.

A narrow form like the preceding, but differing in the prothorax, scrobe, distinct club, &c. Schönherr separated his *Pelororhinus* from Kirby's *Rhinaria*, but he afterwards united them, as Lacordaire thinks, wrongly. The latter, however, was acquainted with but few species, and it is now difficult to satisfactorily differentiate the two. In the Munich Catalogue *Pelororhinus granulosus* of Fähræus is referred to *Rhinaria*.

Ethemaia angusticollis.

E. oblonga, obscure fusca; capite angusto, inter oculos depresso; rostro elongato, antice tricarinato et tuberculato; prothorace subcylindrico, rugoso. Long. 3 lin.

Hab. Cape York.

Narrowly oblong, dull brown; head narrow; continuous with the rostrum, flat between the eyes; rostrum elongate, three raised tuberculate lines anteriorly; antennæ somewhat slender, and scape ferruginous at the base; prothorax narrow, subcylindrical, rugose above; scutellum wedge-shaped; elytra much broader than the prothorax, the shoulders tuberculate,

seriate-punctate, the third interstice towards the apex raised and bituberculate, the fifth interstice also raised and with three tubercles or callosities; legs with appressed whitish setæ.

With a narrower prothorax this species has a longer and more slender rostrum than any of its congeners.

Ethemaia curtula.

E. ovata, griseo-squamosa, setifera; capite inter oculos depresso; rostro crasso, basi bilobo; prothorace latiore; elytris striato-punctatis. Long. 3 lin.

Hab. West Australia.

Ovate, closely covered with pale greyish scales; head depressed between the eyes; rostrum stout, the base with two raised lobes; antennæ ferruginous; prothorax not longer than broad, roughly and unequally punctured; scutellum slightly oblong; elytra short, somewhat quadrangular, striate-punctate, third and fifth interstices raised and tuberculate posteriorly as in the last, punctures large, subapproximate; body beneath and legs scaly, the latter with numerous setæ.

The short elytra and uniform colour differentiate this species from *E. sellata*, which has also a bilobed rostrum.

HYPHÆRIA.

Characteres ut in *Ethemaia*, sed *tarsi* articulo tertio integro.

This genus has all the characters, including the *facies*, of *Ethemaia*, with the exception of the third tarsal joint, which is entire, not bilobed. The general absence of correlation of parts in the Coleoptera, especially in the Curculionidæ, necessarily leads to the multiplication of genera, of which there are about 9000 for ten times that number of species.

Hyphæria assimilis.

H. oblonga, fusca, grisco-squamosa; elytris tuberculis, squamis suberectis nigris coronatis, instructis. Long. $2\frac{3}{4}$ –3 lin.

Hab. Gayndah.

Oblong, brown, closely covered with greyish scales; rostrum continuous with the head, broadly concave anteriorly; head concave in front, the side slightly projecting over the eye, which has also a similar projection beneath; club of the antennæ shortly ovate; prothorax rather longer than broad, coarsely punctured, broadly concave in the middle; scutellum oblong; elytra parallel at the sides, abruptly declivous behind, unequally punctured, with two rows of tubercles, four on each row, tubercles crowned with black semierect scales;

anterior tibiæ subflexuous, thicker towards the base, the apex in all fringed with black conical scales.

MYARDA.

Caput angustum. *Oculi* grosse granulati. *Rostrum* breve, crassum, apice dilatatum; *scrobes* apicales, flexuosæ, infra oculos terminantes. *Antennæ* breviusculæ, tenuatæ; *funiculus* septem-articulatus; *clava* ovata, distincta. *Prothorax* basi bisinuatus. *Scutellum* distinctum. *Elytra* prothorace latiora, subparallela, apice abrupte declivia. *Femora* in medio incrassata; *tibiæ* rectæ; *tarsi* angusti, articulo tertio integro; *unguiculi* liberi, divergentes. *Pro- et mesosterna* prominentia. *Abdomen* segmentis duobus basalibus ampliatis.

This genus agrees with the *Aterpinæ* in its abnormal rostrum (its peculiarities are specific) and mutic tibiæ, the posterior with open corbels; it disagrees in its narrow tarsi, the third joint not divided, as in *Pyphæria*, and the antero-inferior margin of the pectus entire. *Aparete* (Linn. Soc. Journ. x. p. 165), although very different in general appearance, is separated by its flexuous anterior tibiæ, and seventh joint of the funicle not distinct from the club.

Myarda ferrugata.

M. sat breviter ovata, silacea, setis reflexis adspersa; crista supra oculum ad apicem rostri protensa; elytris leviter striato-punctatis, postice tuberculis sex munitis. Long. $3\frac{1}{4}$ lin.

Hab. Nicol Bay.

Rather shortly ovate, yellowish brown, with scattered, reflexed, almost procumbent setæ; head deeply concave in front, an elevated crest above each eye, continued to the apex of the rostrum, forming a groove between them continuous with the concavity on the head; scrobe beginning at the apex, and visible from above; eyes nearly round, but in contact with a rounded ledge below; two basal joints of the funicle about equal in length; prothorax subtransverse, irregularly punctured, slightly angulate at the sides; elytra much broader than the prothorax, striate-punctate, the interstices scarcely raised, except towards the apex, the abrupt portion with three tubercles or callosities on each side, punctures shallow and not approximate; body beneath and legs yellowish brown; posterior coxæ widely apart.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.

November 7, 1883.—J. W. Hulke, Esq., F.R.S.,
President, in the Chair.

The following communications were read:—

1. "Notes on Brocchi's Collection of Subapennine Shells." By J. Gwyn Jeffreys, Esq., LL.D., F.R.S., F.G.S.

In this paper the author gave the results of an examination of the collection of fossil shells from the Subapennine Pliocene described by Brocchi in his '*Conchiologia fossile Subapennina*,' and now preserved in the Museo Civico at Milan. He stated that the collection appeared to have been more or less tampered with, several species are unrepresented, and in other cases the specimens on the tablets with Brocchi's labels have evidently been subsequently and erroneously placed in their present situation. There are, however, many undoubted types. The author cited 55 of Brocchi's species, upon most of which the collection furnished more or less interesting information. In conclusion he remarked upon the importance of identifying Brocchi's species with forms still living in the neighbouring seas, and also upon the difficulty of distinguishing between the Upper, Middle, and Lower Pliocene in Italy. From his examination of Italian Pliocene shells he concluded that the deposits containing them were for the most part formed in comparatively shallow water, probably not more than 50 fathoms in depth, a remark which also applies to the Italian Miocene; and that in the case of species still existing no difference can be recognized between Pliocene and recent specimens.

2. "British Cretaceous Nuculidæ." By John Starkie Gardner, Esq., F.G.S.

The author commenced by discussing the question whether the Nuculidæ should be separated as a family from the Arcidæ, and stated that species of *Leda* and *Nucula* exist and sometimes abound in the marine Cretaceous deposits, with the exception of the White and the Red Chalk, from which, however, he thought that the shells may have been dissolved out. He also referred to the probable derivation of the species from preexisting forms, and discussed the question of how far the relationships thus established could be expressed in the nomenclature of the species, his researches upon the Nuculidæ leading him in some cases to suggest a trinomial nomenclature. The probable lines of descent of the shells described in the present paper were also discussed at some length.

In the genus *Nucula* the author distinguished certain groups typified by particular species, his trinomial system of nomenclature consisting in the intercalation of the names of the latter between the generic name and the definitive specific name of the individual

species. These groups, with their included species, were as follows:—

Group OVATÆ.

OVATÆ LÆVIGATÆ:—*Nucula ovata*, Mant., Gault; *N. obtusa*, Sow., Blackdown; *N. planata*, Desh., Neocomian; *N. cap-sæformis*, Mich., Gault.

OVATÆ RETICULATÆ: *N. Mejeri*, sp. n., Blackdown; *N. arduennensis*, Orb., *pumila*, var. nov., Gault.

Group IMPRESSÆ.

N. albensis, Orb., Gault; *N. impressa*, Sow., Blackdown; *N. Cornueliana*, Orb., Neocomian; *N. simplex*, Desh., Neocomian.

Group ANGULATÆ.

ANGULATÆ PECTINATÆ:—*N. pectinata*, Sow., Gault; *N. pectinata cretæ*, sp. n., Grey Chalk; *N. bivirgata*, Sow., Gault; *N. antiquata*, Sow., Blackdown.

ANGULATÆ LÆVIGATÆ:—*N. gaultina*, sp. n.

Of the genus *Leda* no formal grouping was proposed; ten British Cretaceous species were described. In conclusion, the author discussed the stratigraphical distribution of the species of the two genera.

Dr. GWYN JEFFREYS doubted the necessity of forming a separate family of Nuculidæ. He included them in the Arcidæ. He had examined the Gault collection of Mr. Gardner, which appeared to contain ten times as many species as had already been described from that formation. He considered that the Gault Nuculidæ lived at a depth of from 50 to 100 fathoms, and this view was confirmed by the nature of the materials forming the Gault clay.

Prof. T. RUPERT JONES said that in many parts the Gault swarms with Microzoa, and these seemed to confirm Dr. Gwyn Jeffreys's view that the Gault was formed at a depth of about 100 fathoms.

The AUTHOR thought that the limited area covered by the true Gault clays and the presence of coniferous wood and fruits pointed to the conclusion that the Gault was an estuarine deposit. He believed the evidence indicated that the Gault was deposited in a gradually deepening sea.

MISCELLANEOUS.

On the Internal Sacculina, a new Stage in the Development of
Sacculina Carcini. By M. YVES DELAGE.

WHEN, in studying the embryogeny of *Sacculina*, one seeks on crabs for smaller and smaller individuals, one is soon struck by the

fact that no *Sacculinae* are to be found of a less size than about 3 millim. I have examined several thousand infested crabs without ever finding a smaller *Sacculina*. The embryogeny of *Sacculina* and of the other Rhizocephala not being known, one could only form hypotheses as to their development; and the hypothesis generally accepted is that the Cypridian larva of the parasite attaches itself by the head to the abdomen of the crab, loses its limbs, and insinuates into the tissues of its victim a part of its head, from which spring tubes which invade the whole of the crab. M. Giard has even gone so far as to specify the facts, asserting that the parasite was formed during the copulation of the crabs. If this was true the fact that I have pointed out would be truly inexplicable, for between a *Sacculina* of 3 millim. and a *Cypris* of not more than 0.2 millim. in length there is a whole series of intermediate states which ought to be found. Moreover the smallest *Sacculinae* are already like the adults, and have nothing in common with an active animal, or even with one capable of locomotion. How, then, could the parasite come thus completely formed from without? The answer is easy. It does not come from without, but from within. Before showing itself externally the *Sacculina* already exists in the abdomen of the crab, between the intestine and the wall of the body. It exists thus complete, with its sac, its ovaries, its accessory glands, its testes, and its nervous system, and it is only by increasing in size that it produces by compression necrosis of the integuments of the crab, thinning and finally rupturing them to break through to the outside.

In the youngest state in which one can find it, the *internal Sacculina* consists of a membrane in the form of a flattened sac, stretched between the intestine and the abdominal wall of the crab in the general body-cavity, in the midst of a cellulo-adipose tissue. From the whole of its surface, but especially from its irregularly sinuous margins, issue tubes which, even at this period, have completely invaded the crab. The wall of the membrane is clothed with a thin chitinous layer and formed of large cells with voluminous nuclei. The interior is formed of stellate cells, the processes of which, anastomosing with each other, convert the whole into a sort of cavernous connective tissue, the innumerable cavities of which all communicate with one another. The large parietal cells are continued into the tubes. In its median region the membrane, instead of remaining thin, becomes suddenly thickened, and forms a sort of tumour upon its surface. In the midst of the abundant cavernous tissue which fills this swelling there is a spherical aggregation of small cells, to which I give the name of *nucleus*. The cells of the nucleus are arranged so as to form a central mass, separated by a narrow space from an enveloping layer. At this period the entire *Sacculina* is not more than $\frac{1}{2}$ millim. broad; the nucleus is hardly 0.05 millim. in diameter; and yet every thing that will constitute the adult *Sacculina* is represented in it. The membrane, with its cavernous tissue, will form the *basilar membrane*; the nucleus will form the *external Sacculina*; in this nucleus the spherical layer of

cells represents the *sac*, and the central aggregation the future *visceral mass*.

It is to be remarked, that at this moment all the cells of the nucleus are identical. None of them has become differentiated, either in its nature or in its position. In consequence of transformations that I have been able to follow step by step, and which will be described in detail in a memoir of which these notes are only a precursor, we see successively formed in the nucleus all the parts of the adult *Sacculina*. In the peripheral layer the cells increase in number, those of the margins become elongated radially, anastomose, and form sheaves of connective tissue; the more central ones become elongated and anastomose tangentially, and form muscular fibres. In the central aggregation the peripheral layers undergo an analogous transformation to form the wall of the visceral mass; of the interior cells some become elongated and anastomose to form the transverse muscular planes, while the others, arranged in two symmetrical groups, remain rounded and furnish the ova, as well as the testicular cells.

Before these modifications are completed we observe the formation, in the portion of the cavernous tissue which separates the nucleus from the wall of the membrane, of two parallel and contiguous planes of cells, placed transversely with regard to the axis of the crab. These cells soon secrete between them a plate of chitine, which splits. The cleft opens and gives access to the nucleus outside the cavity of the tumour in which it was contained. The nucleus gradually pushes itself outwards and comes into contact with the integuments of the crab. Here it still continues to enlarge, becoming developed and gradually acquiring the characters of the young external *Sacculina*. Finally, when it has attained the dimensions of 2.5–3 millim., it bursts the integuments of the crab and presents itself outside. Becoming an external *Sacculina* it then constitutes those young parasites, the smallest that we can see externally under the abdomen of the crabs. The orifice of issue soon becomes regular and all trace of rupture disappears; but in the interior of the crab there still remain the sucking-tubes and the flattened pit (*fosse*) from which the nucleus has issued, and which will form the *basilar membrane* that we have indicated in the adult.

Complementary males.—At the moment when the *Sacculina* has just become external the orifice of its cloaca is closed, and a thin chitinous membrane, attached to the periphery of the latter, surrounds it entirely. In a little time this pellicle ruptures and remains adherent only to the periphery of the cloaca. Young Cyprids then come, and insinuating themselves beneath it, attach themselves by their antennæ to the margins of this orifice. *The fact is constant. All the young Sacculinæ have Cyprids thus attached to their cloaca.* They rarely have only one, usually from two to five; and I have found as many as twelve. This fact had never before been ascertained in *Sacculina*, nor, so generally, in any Rhizocephale. The presence of numerous Cyprids around the cloaca proves clearly

that these creatures fulfil the function of males, as Fritz Müller very distinctly perceived. Subsequently the cloacal pellicle is cast, carrying with it the skins of the Cyprids, and the cloaca opens.—*Comptes Rendus*, November 5, 1883, p. 1012.

On the Fossil Flora of Greenland. By Prof. O. HEER.

Through the author's researches 617 species of fossil plants are now known from Greenland, of which 335 belong to the Cretaceous and 282 to the Tertiary epoch. The Cretaceous plants occur in three distinct stages, described as the beds of Kome, Atane, and Patoot.

In the *Kome beds* vascular Cryptogamia (especially *Gleichenie*) and Gymnosperms (namely 10 Cycadææ, forms analogous to the *Zamia*, and 21 Conifers, including 5 *Sequoia*) are found almost exclusively. The Dicotyledonæ are represented only by a single species, *Populus primæva*. The general character of the flora of these deposits, which may be compared with the Urganian strata, indicates a subtropical climate.

In the *Atane beds* there occur, besides vascular Cryptogamia (some of which are arborescent) and Gymnosperms (8 Cycadææ, 27 Conifers; among others *Cycas Steenstrupi* with well-developed carpels), 90 species of Dicotyledonæ, the appearance of which was very sudden. Here also the flora indicates a subtropical climate. The Atane beds may be compared with the Cenomanian strata.

In the *Patoot beds* 20 vascular Cryptogamia, 18 Gymnosperms, 5 Monocotyledonæ, and 66 Dicotyledonæ have been found. Among the Conifers the most abundant species is *Sequoia concinna*, Heer (branches and fruits), nearly related to the Tertiary *Sequoia Couttsiæ*; *Sequoia Langsdorffii*, Brgr., a Tertiary species, is also frequently met with. The Dicotyledons consist of birches, alders, elms, fig-trees, walnuts, oaks, and planes (the last two genera in great numbers); then come laurels, cinnamons, aralias, magnolias, &c. &c. The Patoot beds also contain marine animals, which enable us to make an exact comparison with the deposits of other countries, and approximate them to the Upper Senonian of Europe, consequently to the Upper Chalk.

The Tertiary flora of Greenland is derived either from an Eocene deposit or from Lower Miocene beds. It includes in all 282 species, 2 of which also appear in the Chalk; 20 others are derived from Cretaceous plants, but the rest show no relationship to the Cretaceous flora. Moreover, tropical forms are entirely wanting, so that the climate had been profoundly modified; the mean temperature of the year in Greenland at the epoch of the Lower Miocene must have been about 12° C. (=53°·6 F.), as evidenced by the presence of two fan-palms, *Magnolia*, *Sapindus*, *Dalbergia*, &c. The Tertiary flora of Greenland has 114 species like those of Europe.—*Bibl. Univ., Arch. des Sci.* October 15, 1883, p. 355.

On the Pelagic Fauna of the Swiss Lakes.

By Dr. O. E. IMHOFF.

The author gives a brief summary of the investigations hitherto

made in the Swiss lakes, from which it appears that up to the present time there have been found more Entomostraca than true pelagic animals. He then describes the results of his own researches upon several of the lakes. He has found nine new representatives of the pelagic fauna, of microscopic dimensions it is true, but, like the Crustacea, represented by a great number of individuals. Among the Protozoa he cites the four following species, two of which belong to new forms:—

Mastigophora : Flagellata—*Dinobryon sertularia*, Ehr.

„ *divergens*, Imh.

Ciliflagellata—*Peridinium tubulatum*, Ehr.

Ceratium reticulatum, Imh.

Also two new species of Infusoria which live attached to Crustacea, namely :—

Epistylis lacustris, Imh.

Acineta elegans, Imh.

Among the Vermes, and especially in the class of Rotatoria, six different forms have likewise been observed :—

Conochilus volvox, Ehr.

Asphanema helvetica, Imh.

Anuraea longispina, Imh.

— *spinosa*, Imh.

Triarthra, sp.

Polyarthra, sp.

In all therefore twelve species, seven of which are quite new.

Dr. Imhof characterizes the true pelagic forms by means of the following two principal remarks :—

1. The animals which are truly pelagic from their birth to their death always swim freely in the water, never going either to the shore or to the bottom of the lake, and never touching the surface of the water, so as to avoid coming directly in contact with the atmospheric air.

2. The true pelagic animals carry their ova (with the exception of the winter-egg) either attached to the exterior of the body or in a sort of incubatory cavity until the young individual, whether immediately like its mother or subject to transformation, can quit the envelope of the egg or the incubatory cavity, and lead at once the mode of existence of an accomplished swimmer.

The author has studied the pelagic fauna of the following lakes :—Zurich, Zug, des Quatre-Cantons, Egeri, Katzen, Greifen, Maggiore, Lugano, Como, and Garda.—*Bibl. Univ., Arch. des Sci.* October 15, 1883, p. 349.

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END OF THE TWELFTH VOLUME.

Fig 5

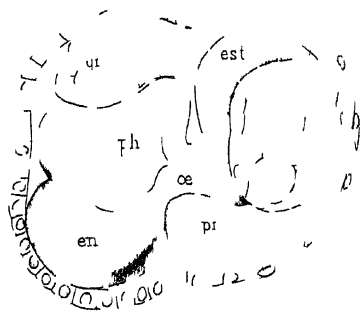
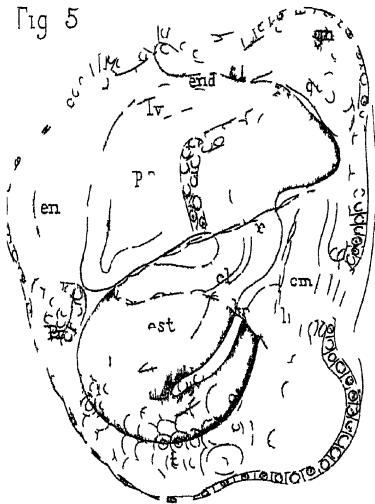


Fig 4

Fig 7

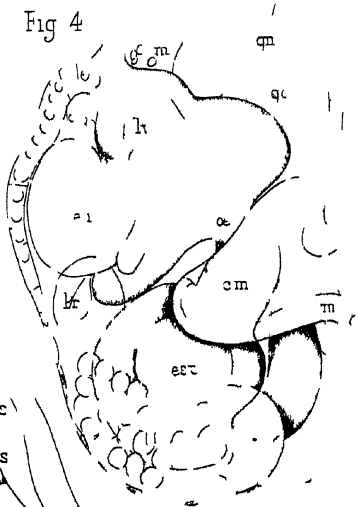
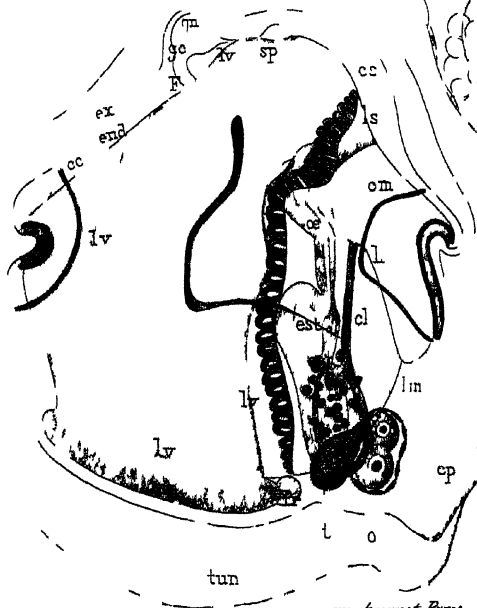
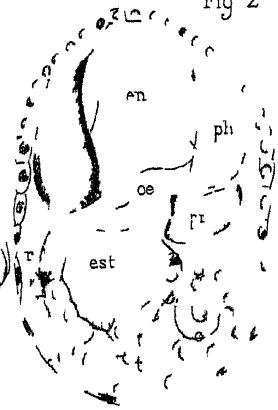


Fig 2



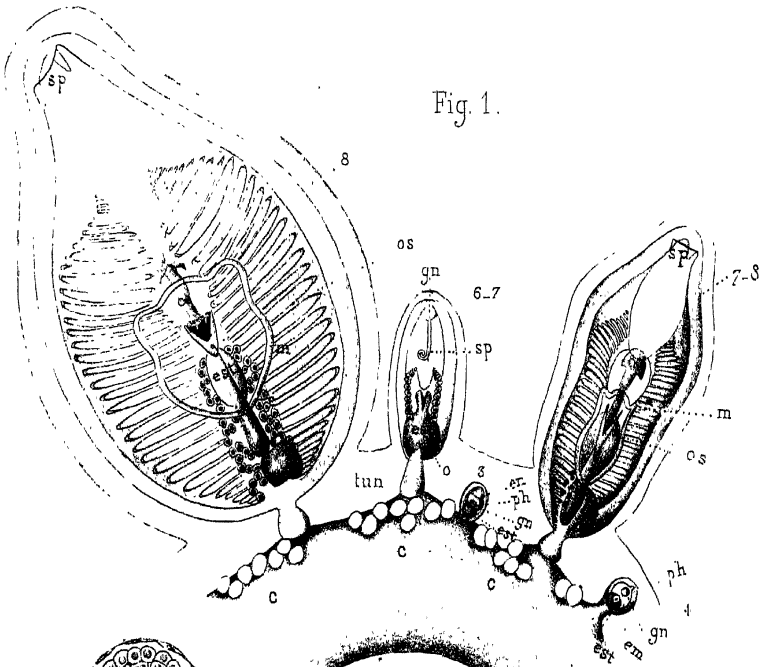


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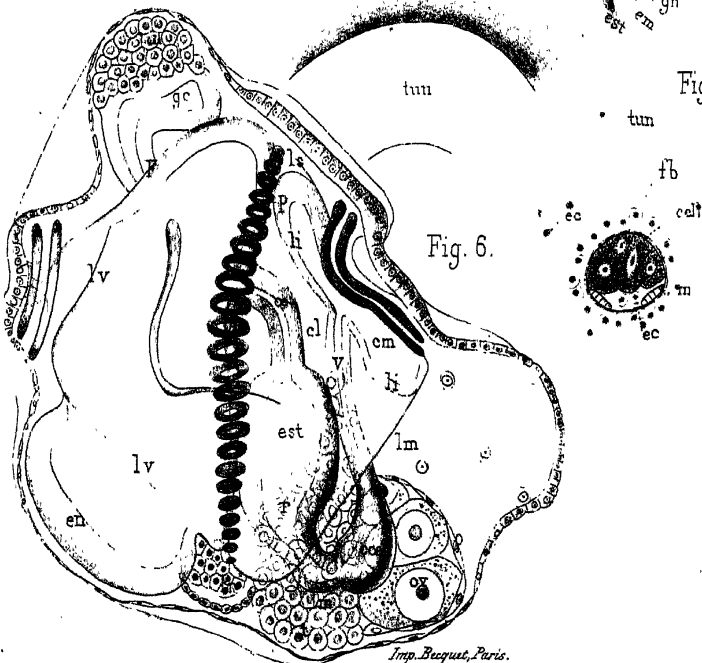


Fig. 6.

Fig 8

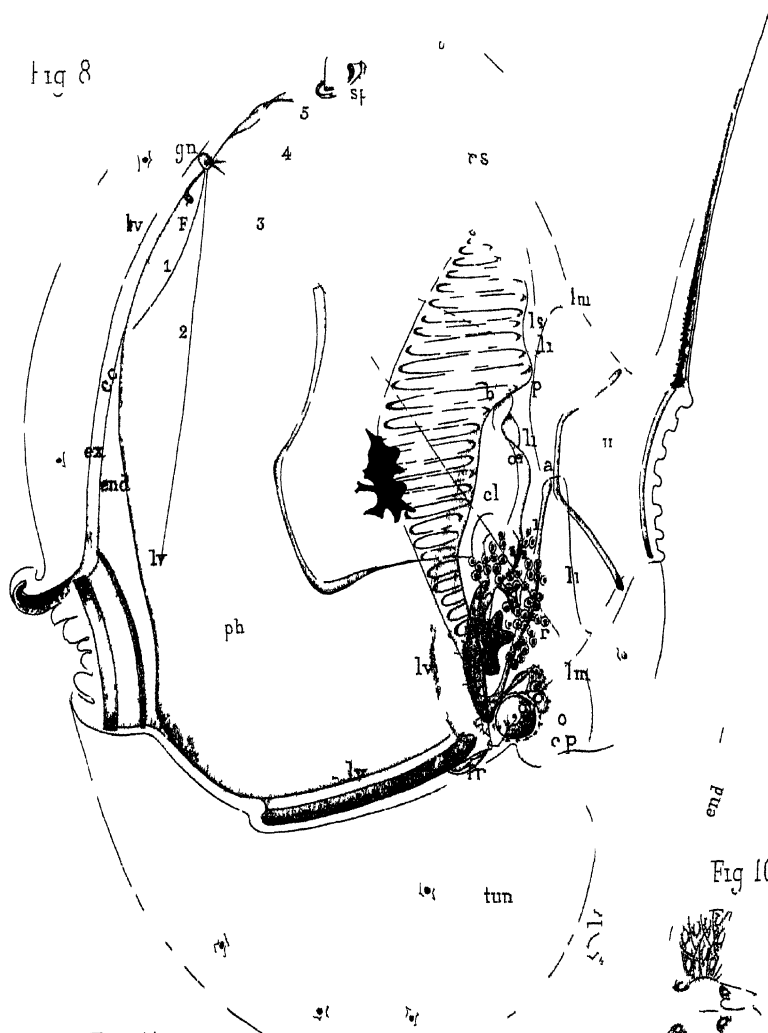


Fig 11

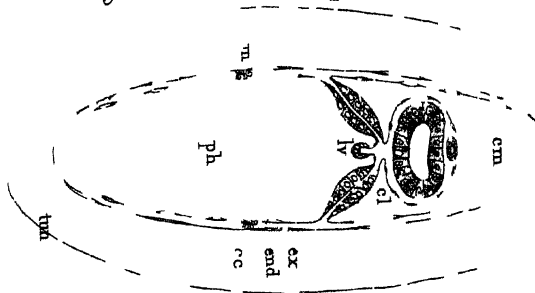
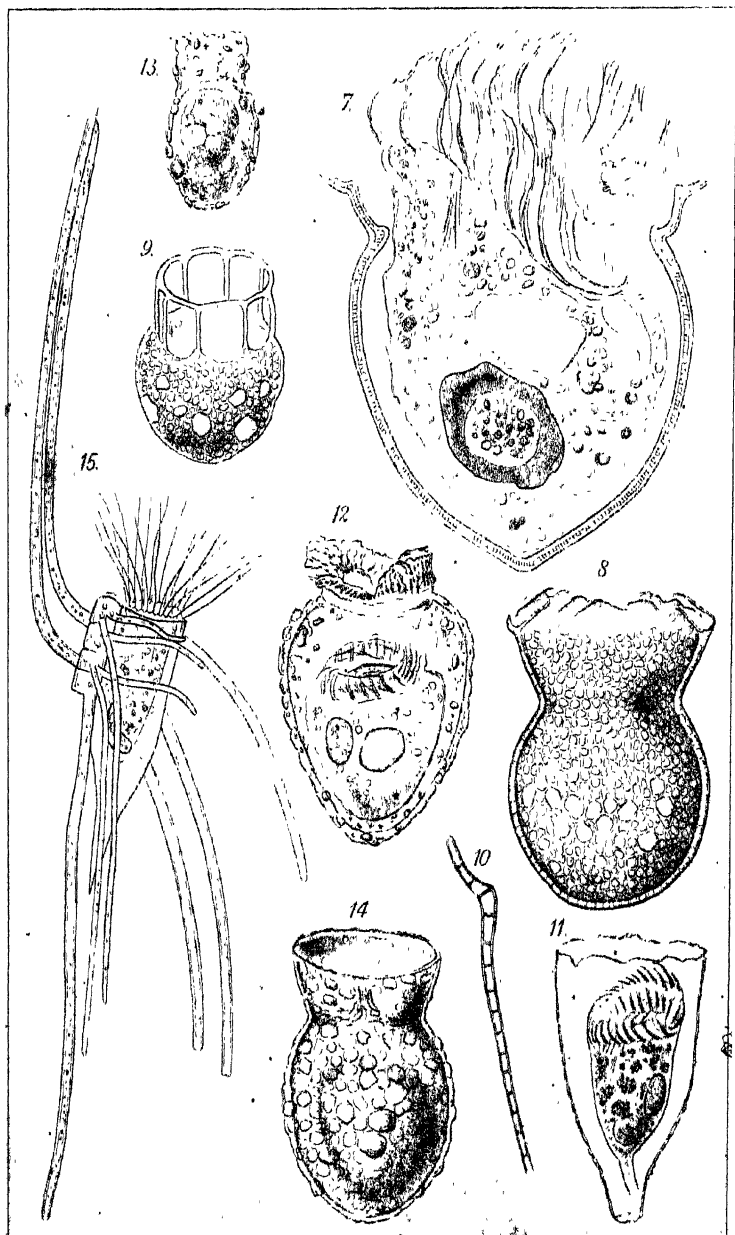


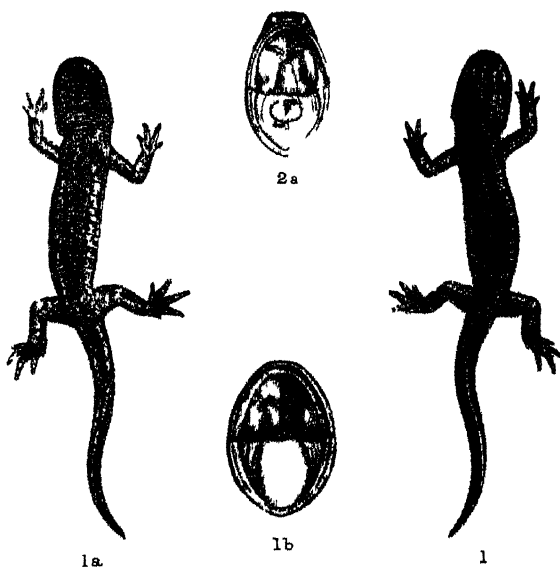
Fig 10







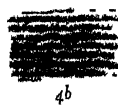
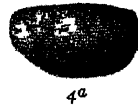
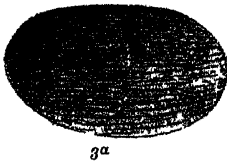
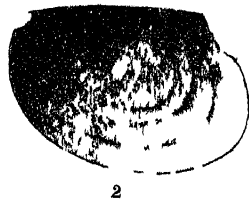
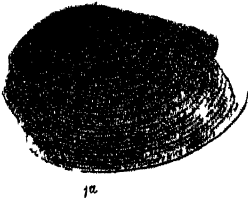
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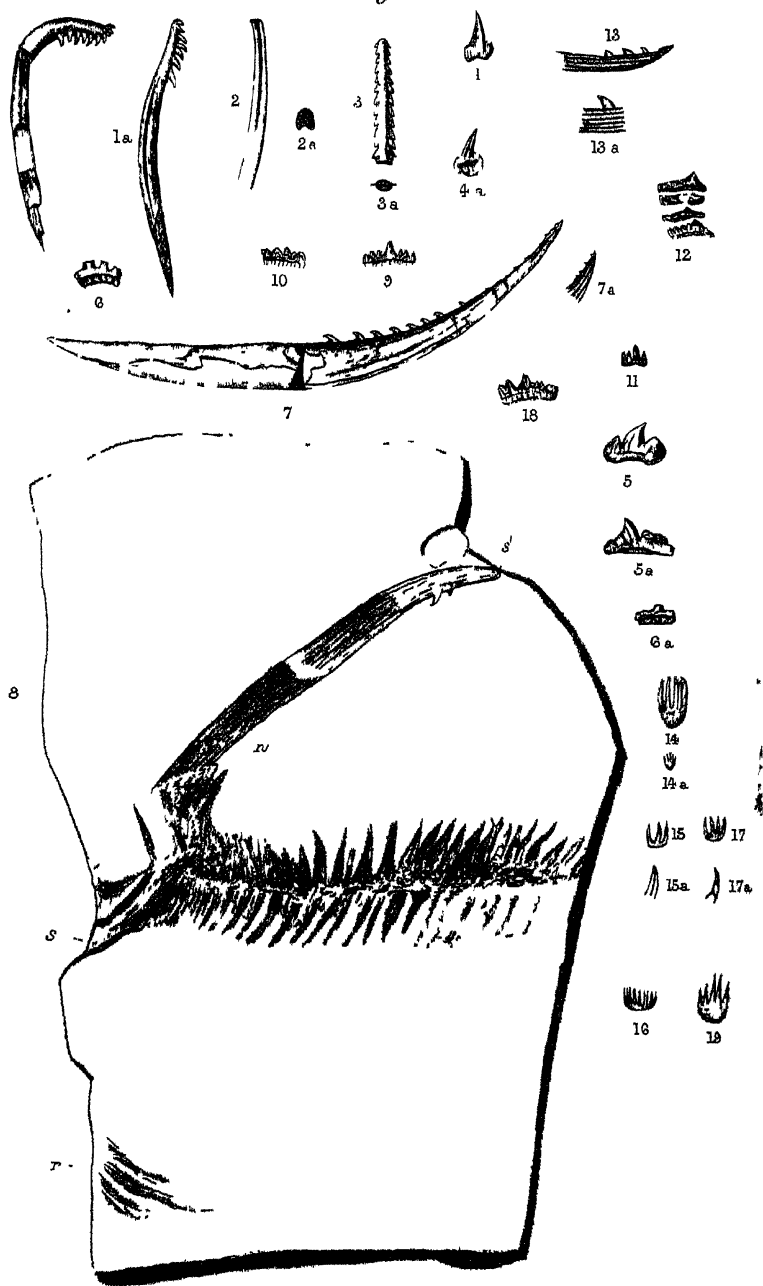
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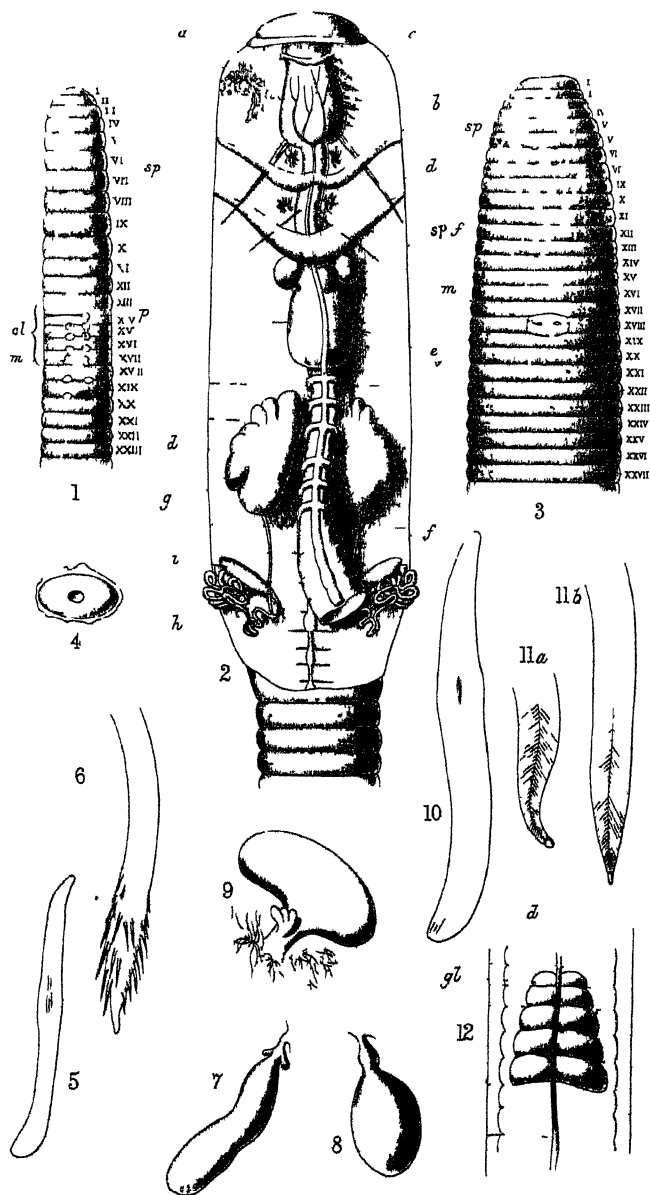


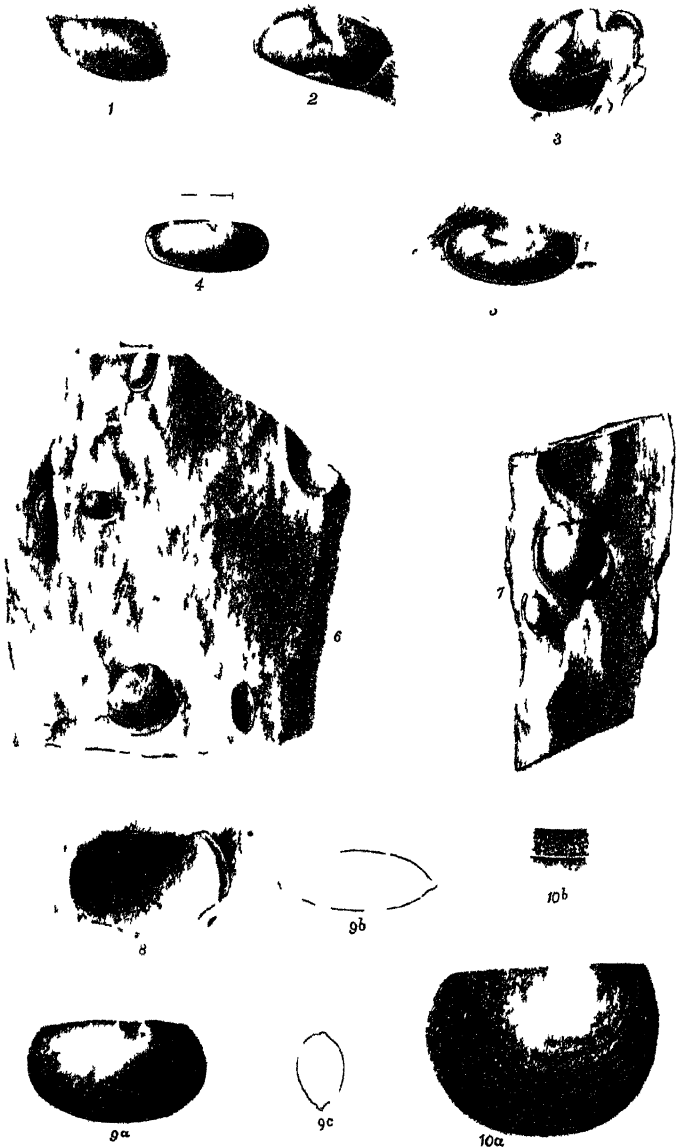
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Fossil Entomostraca from Siberia



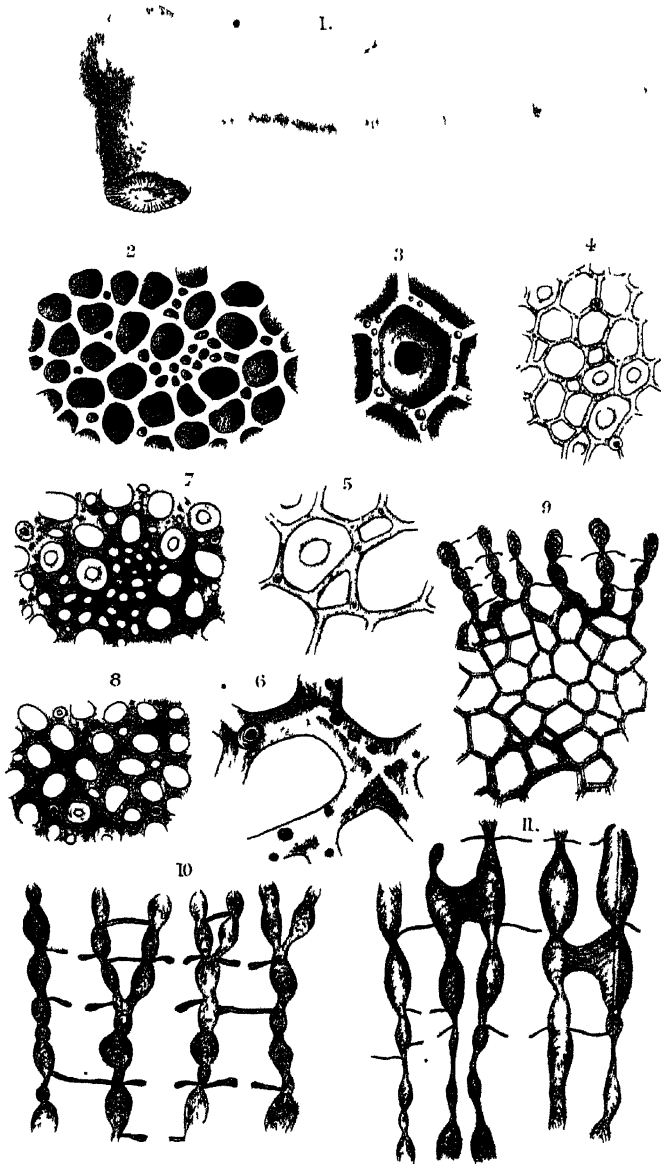


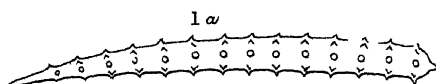


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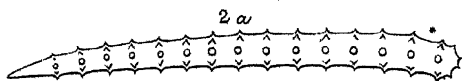
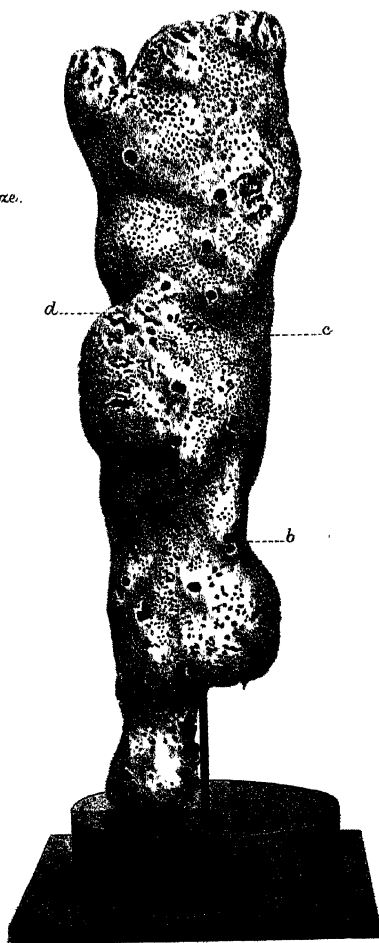
Fossil Entomostraca from Spitzbergen.





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3 a.

